MARYLAND DEPARTMENT OF TRANSPORTATION

STATE HIGHWAY ADMINISTRATION

Office of Structures
Guidelines and Procedures Memorandums

DESIGN SECTION

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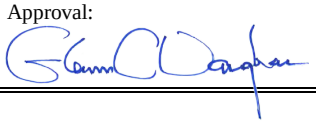
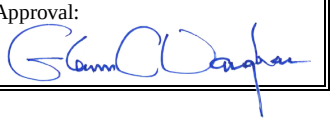
MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION	Office of Structures ***Guidelines and Procedures Memorandum***	DESIGN Number: D-75-4(4) Date: 03-16-2018
Hydraulic Design Criteria for Structures in FEMA Flood Plain		Approval: 

All new and/or rehabilitated hydraulic structures on the State Highway system and on County Roads in Counties having the 100 year Federal Flood Insurance shall be designed so as not to cause any increase in the Water Surface Elevation of the "100 year Flood" for the waterway and its flood plain affected by the proposed construction; therefore, the design storm for the above indicated location shall be a "100 year Storm" for existing conditions as opposed to ultimate development as per existing zoning.

MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION	Office of Structures ***Guidelines and Procedures Memorandum***	DESIGN Number: D-75-6(4) Date: 03-16-2018
Approach Ramp Grades to Pedestrian Overpass and Underpass Facilities		Approval: 

All grades on ramps to pedestrian overpass or underpass facilities shall comply with the latest Americans with Disabilities Act and Architectural Barriers Act Accessibilities Guidelines.

Pedestrian facilities shall have ramp grades not steeper than 1:12 (8.33 percent) with a maximum rise of 30 inches for any ramp run. All ramps shall have level landings that are a minimum of 5 feet long whenever the ramp run reaches a rise of 30 inches. In addition, landings shall also be provided wherever there is a turn in the ramp.

If the ramp system on the approaches to the pedestrian facility becomes excessively long and complex, a separate stairway system should also be provided.

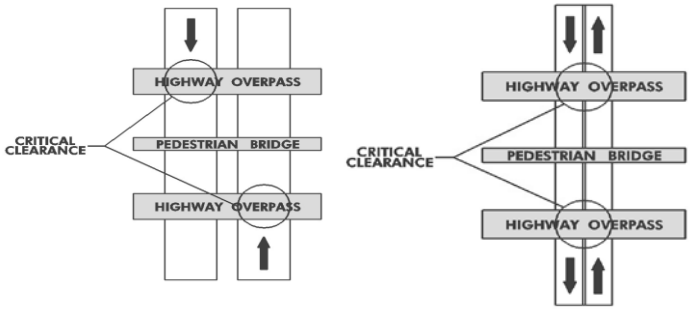
MARYLAND DEPARTMENT OF TRANSPORTATION — STATE HIGHWAY ADMINISTRATION	Office of Structures ***Guidelines and Procedures Memorandum***	DESIGN Number: D-75-7(4) Date: 12-18-2018
Vertical Underclearance for Bridges over Highways and/or Roads, and Bridges with Overhead Bracing		Approval: DRAFT

In order to meet AASHTO Specifications and to accommodate the increased depth of resurfacing on highways under bridges the design vertical underclearances are to be the following:

1. For all bridges (except pedestrian bridges) over Arterial Roads (Rural and Urban) or over Freeways, the minimum design vertical underclearance is to be 16'-9", which provides for 16'-0" absolute minimum and 9" of future surfacing.

2. For all bridges (except pedestrian bridges) over Local Roads and Streets, or over Collector Roads and Streets, the minimum design vertical underclearance is to be 15'-0", which provides for 14'-6" absolute minimum and 6" of future surfacing. (AASHTO only requires a 14'-0" absolute minimum. By providing 14'-6", there will be a 1' minimum clearance above the Maryland legal vehicle height of 13'-6".)

3. For pedestrian bridges, the underclearances specified in 1 and 2 above shall be increased by 1'-0". However, if there are highway overpass structures in close proximity of the proposed pedestrian bridge that have an underclearance greater than the minimum required underclearance of the pedestrian bridge and no access points between the highway overpass bridge and the pedestrian bridge – then the pedestrian bridge shall have its underclearance increased as determined by the Director. See below.



Dual Highway Two Way Single Road

4. For any bridge with overhead structural elements (e.g. movable bridges with overhead bracing for counterweights or through truss bridges, etc.), the vertical clearance to the overhead structural element shall be 17'-6" minimum.

5. For locations where the underclearace is below 14'-6" and cannot be revised due to geometric or structural constraints, the design should be modified to resist impact by over height vehicles. The modifications shall include increasing the bottom flange and adding cross frames/diaphragms to transfer the impact load to the bridge deck.

These underclearances apply to the entire usable roadway area, including shoulders.

MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION	Office of Structures ***Guidelines and Procedures*** ***Memorandum***	DESIGN
		Number: D-75-7(4)
		Date: 12-18-2018
Vertical Underclearance for Bridges over Highways and/or Roads, and Bridges with Overhead Bracing		Approval: See Sheet 1

The actual computed vertical underclearance shall be shown for each bridge in a project. The Point of Minimum Vertical Underclearance shall be shown in the General Plan. The location and actual underclearance shall be shown on the Elevation view. Should a bridge cross more than one roadway (e.g. two directional traffic), the actual vertical underclearance shall be shown for each roadway.

Temporary reductions in underclearance during construction may be required. When a temporary reduction in underclearance provides less than 16’-0” for bridges over Arterial Roads, or Freeways or less than 14'-6” for bridges over Local or Collector Roads and Streets, the work area shall be signed with the reduced underclearance caused by construction. If circumstances require the underclearance be less than 14’-6”, then consideration should be given to temporarily closing the road below during construction.

Contract Documents should be prepared in such a way that Contractors are encouraged to maintain as much underclearance as possible during construction. When the signage noted above becomes necessary, the initial cost of supplying and placing the signs will be incidental to other items in the contract. When circumstances require the closure of lanes under a bridge due to underclearance restrictions, then consideration should be given to including lane rental provisions in the contract to ensure timely completion of the work.

NOTE: For additional information, see AASHTO LRFD 2.3.3.2.

MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION	Office of Structures ***Guidelines and Procedures Memorandum***	DESIGN Number: D-76-9(4) Date: 03-16-2018
Selecting Superstructure Type		Approval:

Generally designers should try to develop superstructures for bridge over water and railroads using concrete as the material for the main supporting members and steel for bridges over highways. Weathering steel should be considered when using structural steel to span over an area where future cleaning and painting operations would be difficult to construct.

This directive applies to all projects on the MDOT State Highway Administration system. Projects prepared for other municipalities, etc. and reviewed by this Office shall be evaluated and commented on, with the above in mind, however, the desires of the owners shall be given prime consideration.

Refer also to the MDOT Policy Manual located at https://policymanual.mdot.maryland.gov under the following - Practical Design Implementation, Bridge, Superstructure Material Selection

MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION	Office of Structures ***Guidelines and Procedures Memorandum***	DESIGN Number: D-77-11(4) Date: 03-16-2018
	Electro-Slag Welding	Approval:

Based on preliminary results of recent research and the actual observations in the field, the use of electro-slag weldments on main structural tension members will not be permitted. This restriction will continue until such time as the quality of this weld can be ensured by possible modification in the welding process and/or improvement in the inspection and quality control procedures which appear necessary at this time.

Because the economic advantage of this type of weld will be lost by this restriction, other types of welding processes in thicker material will become costly and provide opportunity for welding complications. Accordingly, the use of main member tension material in excess of 2 inches thickness is to be avoided wherever possible by modification in the structural components or in the material makeup of the individual structural member.

Based on FHWA Notice N 5040.23 dated February 16, 1977

MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION	Office of Structures ***Guidelines and Procedures Memorandum***	DESIGN Number: D-77-13(4) Date:
Fencing/ Protective Barrier on Structures		Approval: DRAFT

For guidance on the placement of fencing on Highway Structures, refer to Chapter 2.4 of the MDOT SHA Bridge Railing Manual.

MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION	Office of Structures ***Guidelines and Procedures Memorandum***	DESIGN Number: D-77-14(4) Date: 08-01-2018
Bridge Deterioration Preventative Measures		Approval:

All projects shall incorporate the following provisions for prevention of future deterioration.

I. Concrete decks for bridges where the main support system is composed of a longitudinal stringer pattern or stringer and floor beam system.

A. New bridges and bridge deck replacements

1. Provide 2 1/2 inches of concrete cover over the top mat of reinforcing steel in the deck slab. The top 1/2 inch is considered an integral wearing surface and should not be considered in the design strength of the slab.

2. Use Mix No. 6 concrete (4500 psi, air entrained) with synthetic fibers for the entire superstructure.

3. Use epoxy coated reinforcing steel for the entire superstructure.

4. All decks shall receive a coating of linseed oil where it does not conflict with opening of bridge to early traffic use.

5. All roadway joints shall be water tight.

a) For compression/strip seal type joints the protection shall extend up the entire height of parapets, curbs, raised medians and sidewalks. As a secondary measure a trough system shall be placed under the compression/strip seal joint to capture any leakage that could reach a bridge seat area.

b) For toothed type joints a foam seal shall be placed directly below the tooth plate to prevent debris and drainage from entering the joint. This protection shall extend up the entire height of parapets, curbs, raised medians and sidewalks. As a secondary measure a trough system shall be used to capture any leakage that could reach a bridge seat area.

6. Minimize the number of bridge deck roadway joints.

a) For new bridges see GPM No. D 87-38(4) - Guide to Selection of Proper Roadway Joints and Location of Fixed Bearings.

b) For existing steel stringer bridges with multiple simple spans requiring major substructure repairs in addition to a deck replacement, consideration shall be given to replacing the existing structural steel with new continuous stringers. An evaluation of the existing substructure units must be performed to determine if continuous stringers can be supported.

c) For existing simple span stringer bridges requiring minor or no substructure repairs in addition to a deck replacement, evaluate making the stringers continuous for live load by pouring a concrete end block around the ends of the stringers at the piers.

B. Bridge deck rehabilitations (overlays)

1. Remove a uniform thickness off an existing deck. This can vary from 1/4 inch minimum scarification to removal down to within 1" of the top mat of reinforcing steel. Depth of removal is to be determined by the designers based on depth of deterioration and overlay thickness. On new decks not exposed to traffic, sandblast or water blast the entire deck surface. Cores and Ground Penetrating Radar Testing can help to identify the depth of rebar.

2. All areas of deteriorated and/or contaminated concrete beneath that removed in item 1, shall be removed and repaired according to the Specifications.

3. Place overlay to required thickness. Concrete for the overlay shall be latex modified placed at a minimum depth of 1 1/2 inches.

4. All roadway joints shall be water tight.

a) For compression/strip seal type joints the protection shall extend up the entire height of parapets, curbs, raised medians and sidewalks. As a secondary measure a trough system shall be placed under the compression/strip seal joint to capture any leakage that could reach a bridge seat area.

b) For toothed type joints a foam seal shall be placed directly below the tooth plate to prevent debris and drainage from entering the joint. This protection shall extend up the entire height of parapets, curbs, raised medians and sidewalks. As a secondary measure a trough system shall be used to capture any leakage that could reach a bridge seat area.

5. Consideration shall be given to the use of a cathodic protection system when slab is a part of the main support system (Concrete Box Girders). Evaluation is to be made on a case-by-case basis. If a cathodic protection system is used see Section II below for additional design considerations.

C. Bridge deck widenings (where portion of the existing deck will remain)

1. Use Mix No. 6 Concrete and epoxy coated rebar for all bridge widenings.

2. If the existing deck has no hot mix asphalt pavement (h.m.a.p.) and is to remain without any remedial work then the bridge shall be widened as in Section A above. If the bridge has a h.m.a.p., and is going to remain without any remedial work, then the widened portion shall be constructed to allow extension of the h.m.a.p. onto the new deck, so that the longitudinal joint between the h.m.a.p. and the new poured to grade deck coincides with a proposed lane or shoulder line. This will necessitate constructing the new portion of deck to be overlaid to the same plane as the top of the existing concrete deck and then stepping up at the longitudinal lane/shoulder joint to match the finished roadway surface. Efforts should be made to eliminate the h.m.a.p. since it will increase the rate at which the underlying concrete deck will deteriorate. Consideration should be given to removing the existing deck back to a proposed lane or shoulder line and constructing the widened deck without a h.m.a.p. Consideration should also be given to eliminating h.m.a.p. and staining new concrete black.

3. If the existing deck is to remain and receive a concrete overlay, then for widenings less than 12 feet wide, the widened portion shall be constructed to the same plane as the top of the existing concrete deck and then the entire bridge deck shall be overlaid (See I.B.1.). For widenings 12 feet and greater the widened portion shall be constructed to match the finished roadway surface as in Section A above and only the existing bridge deck shall be overlaid.

II. Concrete decks for bridges where the top slab is an integral part of the superstructure (e.g. box girder bridges, does not include decks on steel girders)

A. New bridges

1. Follow all measures outlined in Section I.A above.

2. Place a 1 1/2 inch latex modified concrete overlay.

3. Place chloride sensors beneath the overlay at the top of deck which can detect when the chlorides have penetrated the overlay and reached the deck, so that the new overlay may be replaced.

B. Existing bridges

1. Follow measures outlined in Section I.B above except as noted below.

2. The use of epoxy shall be avoided in making repairs to the existing deck if cathodic protection system is to be used. This includes epoxy rebars, epoxy mortar and epoxy bonding compound.

3. Install a cathodic protection system with chloride sensors on the existing deck prior to placing the overlay.

III. Precast-Prestressed Concrete Girders and Slabs

1. Use Self Consolidating Concrete (SCC) for all prestressed concrete girders and slabs.

2. All reinforcement, except that used for prestressing, shall be epoxy coated.

3. All exposed concrete surfaces of concrete girders and diaphragms shall receive a protective coating.

4. When an overlay is to be placed on slabs or box beams use a 3-inch minimum thick Mix 8 overlay with epoxy coated 6 x 6 - W2.9 x W2.9 welded wire fabric. Provide 2 inches cover from top of welded wire fabric to top of overlay. Prior to overlay, sandblast or water blast top surface of slabs or box beams.

IV. Substructure

1. All reinforcement in all bearing seat pads, abutment back walls, abutment bridge seat areas, and parapet portion of wing walls shall be epoxy coated. All pier cap reinforcement (top 3 feet of solid shaft piers) located under bridge deck roadway joints shall be epoxy coated. All reinforcement which extends into the back walls and wing wall parapets shall be epoxy coated.

2. All concrete abutments and piers located under bridge deck roadway joints shall receive a protective coating. For abutments, coating shall be applied to the entire surface of the bridge seat area and beam pads, the inside surfaces of back walls and cheek walls. For piers, coating shall be applied to the entire surface of the bridge seat area and beam pads.

3. All substructure units in salt water (piles, individual columns and footings) shall receive a protective jacket at the waterline in conformance with the approved Structural Details.

4. Use Mix No. 6 Concrete in abutment back walls and parapets on abutments. All other substructure concrete is to be Mix No. 3.

V. Box Culverts

1. If the culvert has a minimum of 1'-6" of cover (fill material or paving), use Mix No. 3 Concrete and uncoated reinforcing steel for entire box.

2. If the culvert has less than 1'-6" of cover (fill or pavement), the reinforcing bars in the top mat of the top slab (including truss bars and wall steel extending into top mat), shall be epoxy coated and the concrete in the top slab shall be Mix No. 6.

3. If the top slab of the culvert is built to the grade of the finished roadway and the minimum clearance between the top of the rebar mat and the finished roadway surface exceeds six inches, then a mat of epoxy coated 6 x 6 - W2.9 x W2.9 welded wire fabric shall be placed. In addition, all bars in the top mat of the top slab (including truss bars and wall steel extending into top mat) shall be epoxy coated.

4. All top slabs built to grade shall receive a coating of linseed oil where it does not conflict with opening the bridge to early traffic use.

VI. Steel Superstructure Members

1. Non-weathering Steel - Structures using this type of steel will have all exposed surfaces receive a protective paint system.

2. Weathering Steel over a Railroad or Water - Structures using this type of steel will have the following exposed surfaces receive a protective paint system matching the color of weathering steel.

   a) All steel within 10 feet of an abutment

   b) All steel within a 20 foot section centered over a pier

   c) All steel in a span over an electrified railroad

3. Weathering Steel over a Highway or on a Structure Having Drainage Openings Through the Parapets - Structures using this type of steel will have the following exposed areas receive a protective paint system.

   a) In addition to the areas described in 2.a) and 2.b) above, the fascia stringers shall be coated.

MARYLAND DEPARTMENT OF TRANSPORTATION — STATE HIGHWAY ADMINISTRATION	Office of Structures ***Guidelines and Procedures Memorandum***	DESIGN Number: D-78-15(4) Date: 03-16-2018
Length and Treatment of Culverts		Approval: DRAFT

Each culvert shall be evaluated as to the type of end treatment to be used.

All box culverts hall be built with wing walls or have the barrel extended. Non-hydraulic pipes shall have the ends of the pipes beveled to conform to the fill slope with slope protection and cut-off walls unless there are overriding aesthetic concerns. The end treatment for hydraulic pipes shall be determined during design.

For all hydraulic culverts the bottom of the toe wall, wing walls and headwall or slope protection cut-off wall shall be placed 3'-0" minimum below the invert elevation of the culvert. Each site must be evaluated for scour potential and the footings or cut-off walls adjusted accordingly. All of these evaluations are to be made during the preliminary development stages of the structure (i.e. Hydrologic/Hydraulic stage, T.S.&L. stage and Foundation Review stage).

Headwalls for Culverts Carrying 5'-0" or Less Fills (measured at the hinge point):

The length of the culvert shall be determined by placing the concrete headwall so that the traffic barrier on the headwall lines up with the approach traffic barrier. This wil1 necessitate the concrete headwall being placed parallel to the adjacent highway.

Headwalls for Culverts Carrying More Than 5'-0" Fills (measured at the hinge point):

The highway typical section, between hinge points, shall be carried across the culvert. The length of the culvert shall be determined utilizing 2:1 side slopes regardless of approach roadway slope. Refer to Chapters 3 and 7 of the Highway Development Manual.

1) For Culverts Less Than 20 Feet wide (Measured along the center line of the highway)

   The headwall shall be placed normal to the center line of the culvert at a point where the fill over the entire culvert is 9 inches minimum. When setting the length of pipe or pipe arch culverts, the total length should be set in even feet for economy.

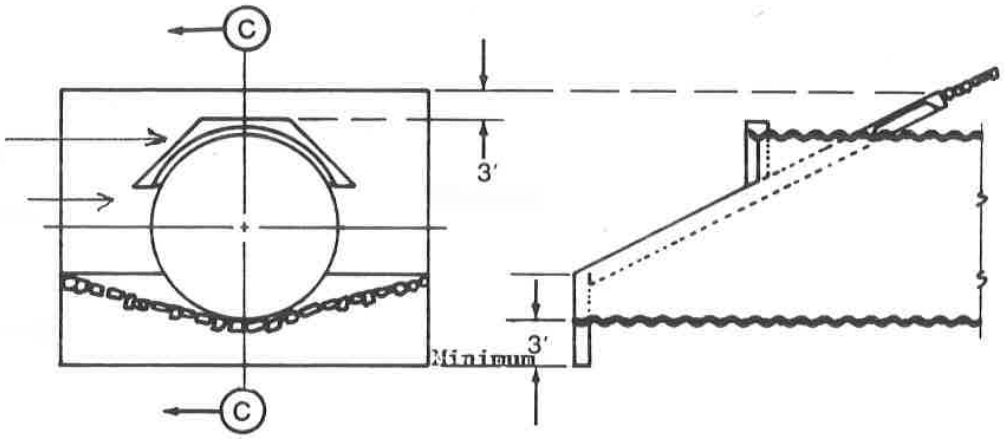
2) For Culverts Greater Than or Equal to 20 Feet Wide (measured along the center line of highway)

   The headwall shall be placed parallel to the adjacent highway. For skew angles between 80 and 90 degrees consideration can be given to placing the headwall normal to the culvert's center line. The location of the headwall shall be determined by economic analysis comparing increased headwall height costs to increased culvert length and earthwork costs.

Length and Treatment of Culverts

Beveled Ends for Culverts

The diagram below shows the typical treatment with slope protection, cut-off walls and a slope collar for one end of a beveled culvert.



Cutting the ends of a culvert to a skew or bevel, which matches the embankment slope, destroys the ability of the end portion to resist the earth pressures.

Designers shall evaluate the skewed end of pipes to ensure proper support is provided. In larger pipes it will be necessary to ensure that the structural plates can carry the unbalanced loads created in the skewed end section and if they can't a headwall must be placed normal to the pipe. On multiple cell pipe culverts this will cause a wall between the pipes to connect the headwall.

In general, when the skew angle between road and the pipe is less than 70 degrees some type of additional end reinforcement should be considered. During backfill and construction of culverts, ends may require temporary bracing to prevent distortions.

MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION	Office of Structures ***Guidelines and Procedures***	DESIGN Number: D-78-16(4) Date:
Traffic Barrier (Parapet) on New or Rehabilitated Structures		Approval: DRAFT

For guidance on the selection of Traffic Barriers (Parapets and Railings) on Highway Structures, refer to the MDOT SHA Bridge Railing Manual.

MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION	Office of Structures ***Guidelines and Procedures Memorandum***	DESIGN Number: D-79-17(4) Date:
	Foundation Evaluation	Approval: DRAFT

The procedure for the establishment of the type and size of a structure's foundation shall be followed after the structure's Type, Size and Location (TS&L) has been approved.

FOUNDATION BORINGS

Foundation Borings shall be requested in accordance with the provisions outlined in this Guideline and Procedure Memorandum. For structures over water, the request for soil borings should be developed/reviewed jointly by a representative of the Structural Engineering /Structure Inspection and Remedial Engineering Division and the Structure Hydrology and Hydraulics Unit to assure that the boring request meets the needs of both units. This would include requests for preliminary soil borings (made prior to T.S. & L. approval) for purposes of evaluating alternative locations of foundation elements such as whether or not to locate a pier in a channel where there is potential for scour or determining the length of a bridge because of marsh areas adjacent to the bridge.

1. Borings will be required for all structures which include but are not limited to bridges, culverts, retaining walls, (includes proprietary walls), noise walls, headwalls, cut-off walls/bulkheads for slope protection, and pipes that are tunneled and/or jacked under roadways.

   Estimated bottom of footing elevations shall be indicated on all boring requests, so that borings and drive tests can be carried a sufficient distance below the estimated bottom of footing to clearly identify the materials upon which the foundations will be bearing.

   Plotting of borings shall be in accordance with GPM No. P-75-3(4).

2. Boring pattern

   a. Bridges - a minimum of two borings for each support shall be requested. If there are dual bridges involved or the equivalent length of a support would compare to dual bridges (i.e., excessive skew angles or narrow median - one structure) a minimum of three borings shall be requested at each support. The exception to this would be long bridges over water with multiple spans where the foundation material is found to be fairly constant. In such conditions the drillers may elect to eliminate borings where possible.

   b. Culverts - A minimum of two borings shall be requested for each culvert. They shall be at each end of the culvert and diagonally opposite from one another. If the center line length of the culvert exceeds 75 feet, additional borings should be requested so that the maximum spacing between borings is 75 feet.

c. Retaining Walls and Noise Walls - At least two borings shall be requested for each wall, one at each end. If the wall length exceeds 75 feet, additional borings should be requested so that the maximum spacing between borings is 75 feet.

d. Headwalls - At least one boring shall be requested for each headwall. If the headwall length exceeds 75 feet, additional borings should be requested so that the maximum spacing between borings is 75 feet.

e. Borings for slope protection cut-off walls will not be required if sufficient soil data is available from other foundation or roadway borings. Where borings are needed, one boring at the midpoint of each cut-off wall will generally be sufficient.

f. Borings for tunneling and/or jacking of pipes should be requested to give a complete knowledge of the type of soil to be encountered in the operation but should not exceed a 75 foot spacing.

EVALUATION OF FOUNDATION TYPES

The proposed minimum bottom of footing elevation shall be plotted on the borings to ascertain the type of material in which it will be placed.

An evaluation shall be made as to whether or not the material can support the intended structure. If it appears that a reasonable lowering of the footing (about 10 feet or less) will reach suitable foundation material then the footing shall be lowered. If it appears that a reasonable lowering of the footing will not reach suitable foundation material then piling shall be utilized. If the depth to good foundation material varies significantly within one footing unit from a pile to a spread footing condition, designers should consider the use of several different pile/ caisson designs to reach the good material from a constant bottom of footing elevation. The Contract should contain a Quantity of Subfoundation Drilling to be used to determine the proper depth of piles/ caissons. In the case of culvert barrels, when less than about 5 feet of poor material can be removed to reach good foundation material, that material shall be removed and replaced with select backfill. When the depth of poor material exceeds 5 feet, piling shall be utilized.

If a footing is to be placed on solid rock with high design bearing pressures, it shall be keyed into the rock at least 1 foot in depth.

All other structures previously constructed in the immediate area should be evaluated as to their selection of foundation type and the field results of the selection i.e. pile lengths, lowering of footings, etc.

HYDRAULIC CONSIDERATIONS

Regardless of type of support, where applicable, all bridges over water shall be evaluated for scour potential. After the preliminary screening, scour critical bridges shall receive a complete scour analysis per the OOS Manual for Hydrologic and Hydraulic Design. The foundation design shall take into account the results of this analysis.

STRUCTURE FOOTINGS

All footings (spread and pile supported) shall have the minimum bottom of footing at least 3 feet below the finished groundline. The bottom of all footings shall be level.

All footings (except abutment footings on piles where the slope protection meets the footing toe) shall have the top of footing at least 1 foot below the finished groundline.

All pile supported footings may be stepped in accordance with the OOS Structural Details whenever it is economical to do so. Each footing step must contain a row of piling at each end of the step.

SPREAD FOOTING FOUNDATIONS

The bottom of a spread footing, including leveling pads for a proprietary retaining wall, shall be placed so that the top of the footing is a minimum of 1 ft below the proposed ground line and the bottom of the footing is a minimum of 3 ft below the proposed ground line. If the footing is to be placed on rock as determined by the Engineer, it shall be keyed into the sound rock at least 1 ft.

Setting spread footings or leveling pads for proprietary retaining walls in embankment or fill material is prohibited. Any spread footing, including leveling pads for a proprietary retaining wall, shall be set into existing in-situ soil or sound rock.

PILE SUPPORTED FOUNDATIONS

If the foundation evaluation indicates that there is a lack of competent soils at an acceptable elevation or significant scour projections are identified, deep foundations shall be utilized. The following is a list of acceptable deep foundations (piles) that may be used on MDOT SHA structures:

1. Steel H Piles - In footings where a rock stratum lies beneath fair to poor material and is reachable with piling, or the material to be driven through consists of boulders or hard driving, steel H-piles shall be utilized.

   If the rock stratum appears to be on an incline then pile tips shall be attached to the piling before driving.

2. Pipe Piles (minimum 1/2" wall) - This type of piling shall generally be used in cases where a friction pile is appropriate and there are hard layers anticipated in driving piling. These piles shall be driven open ended except where the upper layer of soil is soft muddy or mucky material.

3. Micropiles - In footings where short piles (20 feet or less) are anticipated to reach a hard stratum beneath material which is susceptible to scour and/or the hard driving of piles would be detrimental to adjacent properties, pin piles fixed into the hard stratum shall be utilized.

4. Treated Timber Piles - This type of piling may be utilized on timber bridges, bulkheads and fenders.

5. Untreated timber piles - Where piling is required for box culverts and retaining walls and the piling will be totally encased or below ground line, untreated timber piling may be used. It may also be utilized in temporary structures, such as detour bridges.

6. Auger Cast Piles - In footings with small loads and the foundation material is borderline spread footing material, auger cast piles should be utilized.

7. Cylinder Piles - For large marine structures where extensive cofferdams would be required to construct a conventional footing the use of precast prestressed cylinder piles should be considered.

8. Cast-in-place Concrete Piles (thin walled, uniform diameter, helically welded shells and Monotubes) - This type of piling may be considered in cases where a friction pile is appropriate and there are no hard layers anticipated in driving piling.

Note to Designers: Precast Prestressed Piles are not permitted on MDOT SHA structures due to the erratic length of piling and the inability to economically splice these piles.

Driven Piles

Driven piles consist of Steel H-piles, steel pipe piles, or timber piles. Only one type of pile shall be used on each individual substructure unit. However, different substructure units of the same structure may have different foundation types.

Bottom of footings for the bridge abutments or wing walls may be in approach embankments provided they sit on pile-supported foundations with the pile tip elevation set in competent in-situ soil or sound rock. Pile tips shall be applied to driven piles where warranted. Piles shall extend below the elevation of the roadway that is being crossed.

The proposed pile spacing for design shall conform to the following:

1. Spacing in the front row of a pile group shall not exceed 8 ft.
2. Spacing for all other rows shall not exceed twice the spacing of the front row.
3. Pile patterns shall be designed so that no piles are in tension or uplift.

Battered piles shall be used to resist all horizontal loads. The use of plumb piles to resist horizontal loads may be considered on a case by case basis and approved by MDOT SHA prior to the Foundation Review submission. No substructure unit shall have all the piles battered in the same direction. (i.e. in most cases at an abutment, at least the back row of piling shall be vertical or battered in the opposite direction). The maximum pile batter rate permitted will be 4:12, with 3:12 the desirable rate.

Augered or Drilled Piles

Augered or drilled piles consist of micropiles, reinforced cast in place drilled shafts (caissons), and steel H-piles placed in augured holes with voids filled with concrete. Any augered or drilled pile foundation that encounters rock shall have its final tip elevation a minimum of 10 ft into competent rock or 5 ft into sound rock. Steel mini/pin piles shall have a 5’ deep grout bulb below the final tip elevation.

Structural capacity of auger cast piles with steel H-pile cores shall be determined solely on the capacity provided by the steel H-pile core without any contribution of the surrounding cast in place concrete. The augered or drilled pile spacing shall conform to the same criteria as driven piles, excluding mini/pin piles. Pile patterns shall be designed so that no piles are in tension or uplift. Design strength shall be maintained for the full length of the pile.

Test Piles and Load Tests

At least one pile in each footing shall be designated as a test pile on the Plans. The test pile shall be a plumb pile located near the centroid of the pile group it serves. The foundation report shall indicated the recommended pile testing method.

Foundation Evaluation

On structures with an overall length in excess of 250 feet over marshlands or waterways where friction piling is being used load tests shall be utilized to verify pile capacity and lengths. Piles should be load tested to at least twice their design load. Some larger piles may require more.

FOUNDATION REVIEW SUBMITTAL

A separate foundation report shall be prepared for each structure and submitted as part of the Foundation Review, and it shall contain, as a minimum, the information listed below.

Approved T.S & L. Plans including a General Plan and Elevation, Plan and Elevation of each footing and structural unit, and plotted boring and drive test logs.

In addition to the Plans a written report is to be made. It should contain an interpretation and analysis of the proposed structure and boring and drive test data as well as definite engineering recommendations for foundation design. The materials and conditions which may be encountered during construction should also be discussed. The Engineer responsible for the report preparation should have a broad enough background in engineering to have some knowledge of the type of structures which might be used in a certain location, including their foundation requirements and limitations. Problems of design and construction should be anticipated and recommendations made for their solution. The recommendations should be brief, concise, and, where possible, definite. Reasons for recommendations and their supporting data should always be included. Extraneous data which are of no use to the designer or Engineer in the field should be omitted. The written report should include the following items.

1. Type of Foundation: (i.e., pile or spread footing). Each substructure unit shall be addressed separately. If it appears that there is a choice of foundation such as spread vs. piling, then a cost analysis should be utilized for the final decision.

    a. Pile Foundation

        (1) Method of support - friction or end bearing, in rock or soil or both.

        (2) Suitable pile type - reasons for choice or exclusion of types.

        (3) Pile tip elevations.

            (a) Estimated - average values with range of variation if desirable.

(b) Minimum penetration elevation - explain reasons, such as driving through fill, negative skin friction, scour, underlying soft layers, piles uneconomically long, etc.

(4) Pile loadings (Design and Driving)

(5) Settlement consideration - requirements of structure vs. soil conditions.

(6) Cut-off elevations - water table, marine bore problems, etc.

(7) Test pile locations.

(8) Wave equation analysis and need for dynamic monitoring.

(9) Load tests or pile restrikes required.

(10) Effects on adjacent construction.

(11) Corrosion effects of various soils and waters, and possibility of galvanic reaction; need for pile encasement.

b. Spread Footing Foundation

(1) Elevation of footing.

(2) Material on which footing is to be placed.

(3) Nominal and Design (factored) Bearing Resistance (from soil) and Bearing Pressure (from structure).

(4) Settlement analysis. (settlement shall be less than 1")

(5) Slope stability analysis.

c. Scour Evaluation

Regardless of type of support, where applicable, all bridges over water shall be evaluated for scour potential. After the preliminary screening, scour critical bridges shall receive a complete scour analysis and address the following:

(1) Lowering the footings, spur dikes, stone blankets and revised pier alignment.

(2) Where pile foundations are used, piles must be driven deep enough to assure structure stability relative to potential scour depth. (i.e. if scour occurs will structure still be stable.) Consideration must also be given to the potential for pile buckling due to the increased unbraced length.

(3) Spread footings will only be used in rock or with subfoundation concrete where it is not feasible to use piles or lower the footing enough to protect against anticipated scour.

2. Approach Fill Consideration

Settlement of fill embankments should be considered when evaluating structure foundations. To account for any settlement of approach fills designers should consider removing the compressible material and replacing it with suitable backfill material, surcharging the existing embankment (this may include the use of wick drains) to maximize the effect of settlement prior to building the structure, drilling holes through the fill and placing sonotubes through which H-piles could be driven, coating the pile with bituminous material to minimize the effects of negative friction on piles or reducing the allowable loads on the piles to account for the draw down force.

3. Construction Considerations:

a. Water table - fluctuations, control in excavations, pumping, tremie seals, etc.

b. Adjacent structures - protection against damage from excavation, pile driving, drainage, etc.

c. Pile driving - difficulties or unusual conditions which may be encountered.

d. Excavation - control of earth slopes including shoring, sheeting, bracing, and special procedures, variation in type of material encountered, etc.

e. Stray currents - In areas where stray currents from electric facilities may cause rapid deterioration of the rebar, damage shall be minimized by bonding all the rebar together and grounding the rebar system.

MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION	Office of Structures ***Guidelines and Procedures Memorandum***	DESIGN Number: D-79-19(4) Date: 03-16-2018
Design for Future Deck Replacement		Approval:

In order to address maintenance of traffic during future bridge deck replacements, all substructure units shall be designed to support full live load with portions of the superstructure completely removed. For purposes of design assume deck will be replaced one-half at a time. For example, with hammerhead piers particular attention should be paid to the foundation pressures and the reinforcement requirements between the cap and stem, and the stem and the footer.

Designers shall also consider maintenance of traffic during future deck replacements when establishing the superstructure typical section. A minimum of four (4) stringers should be provided on all bridges so that there will be at least two stringers to support a single lane of traffic when the deck is replaced in half sections.

MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION	Office of Structures ***Guidelines and Procedures Memorandum***	DESIGN Number: D-82-25(4) Date: 03/16/2018
Proprietary Retaining Wall Approval Process		Approval: DRAFT

In order for a proprietary retaining wall to be constructed within Maryland Department of Transportation, State Highway Administration (MDOT SHA) right-of-way, the wall must be on the list of Approved Proprietary Retaining Walls maintained by the Office of Structures and posted on the MDOT SHA website (www.roads.maryland.gov). All proprietary wall systems must go through a four (4) step approval process prior to inclusion on the list. It should be noted that the inclusion of a retaining wall system onto the Approved Proprietary Retaining Wall list does not guarantee that it will be used on any project. In addition, a system will only be used on projects where it is reviewed and approved by the Administration prior to advertising and is specified in the Contract Documents.

It should be noted that the approval of a retaining wall system for inclusion on the Approved Proprietary Retaining Wall list does not extend to approval of precast plants or to approval of the materials used to construct the wall. All precasters and materials used on MDOT SHA projects must be approved by MDOT SHA's Office of Materials Technology prior to use.

The approval process for selection and placement on the approved list is as follows:

Step 1 – Request for Inclusion

A retaining wall system representative must request in writing to the Director of the Office of Structures, the desire to be placed on this list. The request must include enough information for the Office of Structures to make a determination based on the following points:

- The system has a sound theoretical and practical basis for the engineers to evaluate its claimed performance.
- Past experience in building and performance of the proposed system.

Step 2 – Wall System Information

Should the system be accepted for consideration, the wall firm representative must submit a package which includes and satisfactorily addresses the following items:

(A) The system theory and the year it was first used;

(B) Where and how the theory was developed;

(C) Laboratory and field experiments which support the theory;

(D) Practical applications with descriptions and color photos. Direction to a manufacturer's website containing this information is acceptable.

(E) Limitations and disadvantages of the system;

(F) Any known failures of the system, including where, how and why it failed. If applicable, include information on how the system was repaired.

(G) List of users (other states, etc.) including contact names, addresses and phone numbers,

(H) Details of wall elements, analysis of structural elements, design calculations, factors of safety, estimated life, corrosion design procedure for soil reinforcement elements, procedures for field and laboratory evaluation including instrumentation and special requirements, if any.

(I) Sample material and construction control specifications--showing material type, quality, certifications, field testing, acceptance and rejection criteria (tolerances) and placement procedures,

(J) A well documented field construction manual describing in detail, and with illustrations where necessary, the step by step construction sequence, and any special equipment required. The document should also include repair procedures.

(K) Typical unit costs, supported by data from actual projects.

Step 3 – Design Evaluation

If, after evaluating this material, the Office of Structures finds the retaining wall system acceptable, the wall firm must have the total system reviewed by an independent professional engineer, registered in Maryland, and acceptable to this Office. A list of professional engineering firms acceptable to this Office is available upon request. If the retaining wall firm selects an engineering firm who is not on the list, the name and qualifications must be submitted to this Office for approval.

The independent professional engineer shall at no expense to MDOT SHA, review the design concepts, specifications, calculations, construction specifications, for compliance with AASHTO, and MDOT SHA criteria. If the independent, professional engineer finds the wall system meets AASHTO and MDOT SHA criteria and so documents in writing, the wall will be added to the approved list, and considered for use at locations deemed appropriate by this Office, based on aesthetics, economy, design requirements and constraints, etc. The independent professional engineer shall stamp the design calculations indicating that they have been reviewed and found to be acceptable. A copy of the stamped calculations will be kept on file.

The design of the proprietary retaining wall system must follow the current AASHTO LRFD Specifications. Design calculations should clearly indicate the date of the specifications and interims used in the wall design.

Backfill material for proprietary walls shall consist of No. 57 stone. A phi (φ) angle of 34° shall be used for No. 57 stone during design.

The maximum approved wall height will be 50 ft.

Proprietary Retaining Wall Approval Process

Step 4 – Submittal of Standard Details

Once a retaining wall system is on the Approved Proprietary Retaining Walls list, the wall firm shall provide standard details and specifications showing panels, leveling pads or footings, earth reinforcements, materials, coping/moment slab, cast-in-place or precast barriers, repair details, etc. for review and approval by the Office of Structures. Once approved by the Office of Structures, they will be stamped and kept on file. For Contracts in which the system is selected, the wall firm shall submit construction plans, etc. using only the approved details, specifications, etc. on file. Shop drawing review will be based on these details.

For information on what is to be included in the advertised contract documents, see GPM No. P 94-38(4), Contract Documents for Retaining Walls.

Revisions to Approved Proprietary Retaining Walls

Should any detail, specification, etc. change during the time it is on the Approved Proprietary Retaining Walls list, the wall firm must submit the revision for review and approval, prior to using that revision on MDOT SHA projects. Revisions may not be submitted for projects which are already bid.

Approval Expiration

The approval of a retaining wall system is good for 10 years from the date of acceptance. To have the retaining wall system approval renewed, the wall system representative must request in writing to the Director of the Office of Structures indicating any changes to the wall system since the prior approval. An evaluation as outlined in Step 3 may be required.

The Administration reserves the right to remove a retaining wall system from the Approved Proprietary Retaining Wall list at any time. Failure to produce substitute project details to be incorporated as a redline revision in accordance with GPM No. P 94-38(4) will be grounds for removal from the Approved Proprietary Retaining Wall List.

MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION	Office of Structures ***Guidelines and Procedures Memorandum***	DESIGN Number: D-84-28(4) Date: 03-16-2018 Approval:

Structure Inspection for Input in Rehabilitation Contract

It is imperative that when an existing structure is being incorporated into a construction project that all problem areas with that structure be addressed in the proposed contract. If the project is being prepared by a consultant, all these measurements, reviews and report shall be their responsibility.

Field Conditions and Geometrics to Be Verified

Field conditions and geometrics need to be checked before finalizing work. Geometric data should be made a part of the survey request. Other data must be verified by MDOT SHA or consultant engineer at the time of the Preliminary Field Investigation or In-depth Inspection.

The items to verify in the field for all projects are:

(1) Type of every roadway joint
(2) Opening of every roadway joint (be sure we evaluate variations along each joint)
(3) Approximate size of every joint seal
(4) Number, locations and condition of joint troughs
(5) Clear roadway width
(6) Type and condition of traffic barrier and/or sidewalk
(7) Type of fencing or railing
(8) Endpost transitions to traffic barrier
(9) Bridge length (including individual span lengths)
(10) Bridge width (including shoulder widths and lane widths)
(11) Utilities being carried by the bridge
(12) Location of overhead and underground utilities

Additional items to verify in the field for a bridge deck replacement, superstructure replacement and widening job are:

(1) Skew angle of piers and abutments
(2) Stringer spacing
(3) Elevations at gutter line, crown of roadway and along roadway joint
(4) Attachments to bridge (signs, lights, etc.)
(5) For dual bridges, evaluate sister bridge for any work necessary that can be incorporated into as planned work.

Additional items to verify in the field for a superstructure replacement and widening job are:

(1) Distance between centerline of bearings of all existing supports
(2) Dimension checks on all substructure units
(3) Dimensions necessary to verify underclearance
(4) Location and length of approach slab
(5) For dual bridges, open distance between bridges

Structure Inspection for Input in Rehabilitation Contract

In-depth Inspection Guidelines

The in-depth inspection shall consist of but not be limited to:

All Exposed Substructure Elements: A visual inspection shall be made to detect any cracks, their depth, location and extent. This review shall include a check for spalling or deterioration of concrete as well as the condition of any exposed reinforcement. A check with a hammer for unsound concrete shall be made. If visual and hammer inspection indicate deteriorated concrete of significant size and depth, cores shall be requested from SHA Geotechnical Exploration Division to determine if major repair or total replacement is required.

Piling: All exposed piling shall be carefully evaluated above the water line and all areas with problems shall be identified.

Bearings: Each bearing shall be checked for rust, corrosion, tilting, alignment, condition of elastomeric pads, if used, or any other material or components in the bridge bearings. Check for any missing or bent anchor bolts, make sure that bearings are functioning properly and are free to move or rotate. Indicate work proposed for each bearing - i.e. leave as is and paint, remove and replace portion, remove and replace entire bearing, etc.

Superstructure Steel: Every member, stringers, floor beams, diaphragms, etc. shall receive visual inspection to check for rust, cracks, corrosion or any defects. Removal of wood planking may be required for adequate inspection. This should be coordinated prior to the inspection. If corrosion is noticed, measurements should be made to determine the loss of section and the capacity of the reduced section. If cracks are noticed or suspected, U.T. inspection should be requested from MDOT SHA Metals Section to detect any existing defects. Identify the location of all cracks.

Concrete Stringers: The same inspection procedure used for substructure concrete should be followed.

Bridge Deck: If the bridge deck is to remain, conduct inspection similar to that for deck evaluation for deck replacement program. The visual inspection should include the wearing surface, if any, the top of deck slabs and bottom of deck slabs where no SIP forms were used, the sidewalks and the parapets. Check for cracking, spalling, delamination, deterioration, etc. If necessary, request testing (i.e. cores, GPR, etc.) from MDOT SHA Office of Material Technology, and based on their recommendations, include any rehabilitation work.

Roadway Joints: If the bridge deck is to remain, check for rusting, leakage and joint condition, and, depending on the type joints, determine whether modification such as adding compression seal would be needed. Trough to be added where none exists, if possible.

Structure Inspection for Input in Rehabilitation Contract

Safety Features: Evaluate roadway under, if applicable, as to protection of piers, etc., need for fencing, approach traffic barrier, etc.

Report on Findings

A report shall be prepared describing the existing structure condition and indicating a definite repair procedure and sketches for any deficiencies found in the structure. The recommendations shall be detailed and not general, i.e. Remove and replace 16 feet of Pier 2 cap, replace bearing #5 on Abut A, etc.

The report should include photographs, illustrating any problems. All suggested repair work shall be evaluated and, if approved by the Director, incorporated in the construction contract.

If work for contract has been previously determined, i.e. deck is to be totally replaced, then that portion of inspection and report shall be eliminated. However, a statement should appear in the report indicating these previous decisions.

MARYLAND DEPARTMENT OF TRANSPORTATION — STATE HIGHWAY ADMINISTRATION	Office of Structures ***Guidelines and Procedures Memorandum***	DESIGN Number: D-85-25(G) Date: 03-16-2018
Layout of Bridges on Non-Tangent Alignments		Approval:

General

On all projects where a proposed structure is on a non-tangent alignment, consideration shall be given to constructing the bridge with straight stringers and parapets.

In order to determine when this is feasible, the ordinate at the inside curve gutter line should be determined using the total length of bridge between centerlines of bearing of abutments. If this ordinate is less than 1 foot (1'-0"), then the structure should be laid out with straight stringers and parapets. This means that the bridge will be somewhat wider than it needs to be and the shoulder widths on the bridge will vary, with minimum required widths maintained throughout.

When a bridge falling within a non-tangent alignment is to be constructed with a straight superstructure, every effort should be made to construct the wingwalls on the same straight line as the parapets. On relatively short bridges, it may be possible to lay out the wingwalls along the same line as the bridge superstructure without exceeding the 1 foot maximum ordinate.

This is the most desirable case. If the wingwalls need to be kinked at a slight angle to the bridge superstructure, in order to accommodate the clearances, then the size of this kinked angle will depend upon the length of the wingwalls and the degree of roadway curvature. The clear roadway width between wingwalls will be somewhat wider than necessary and the shoulder widths will vary, with minimum required widths maintained throughout.

On bridges with curved superstructures, the designer should still attempt to lay out the wingwalls straight, using the same procedure as above.

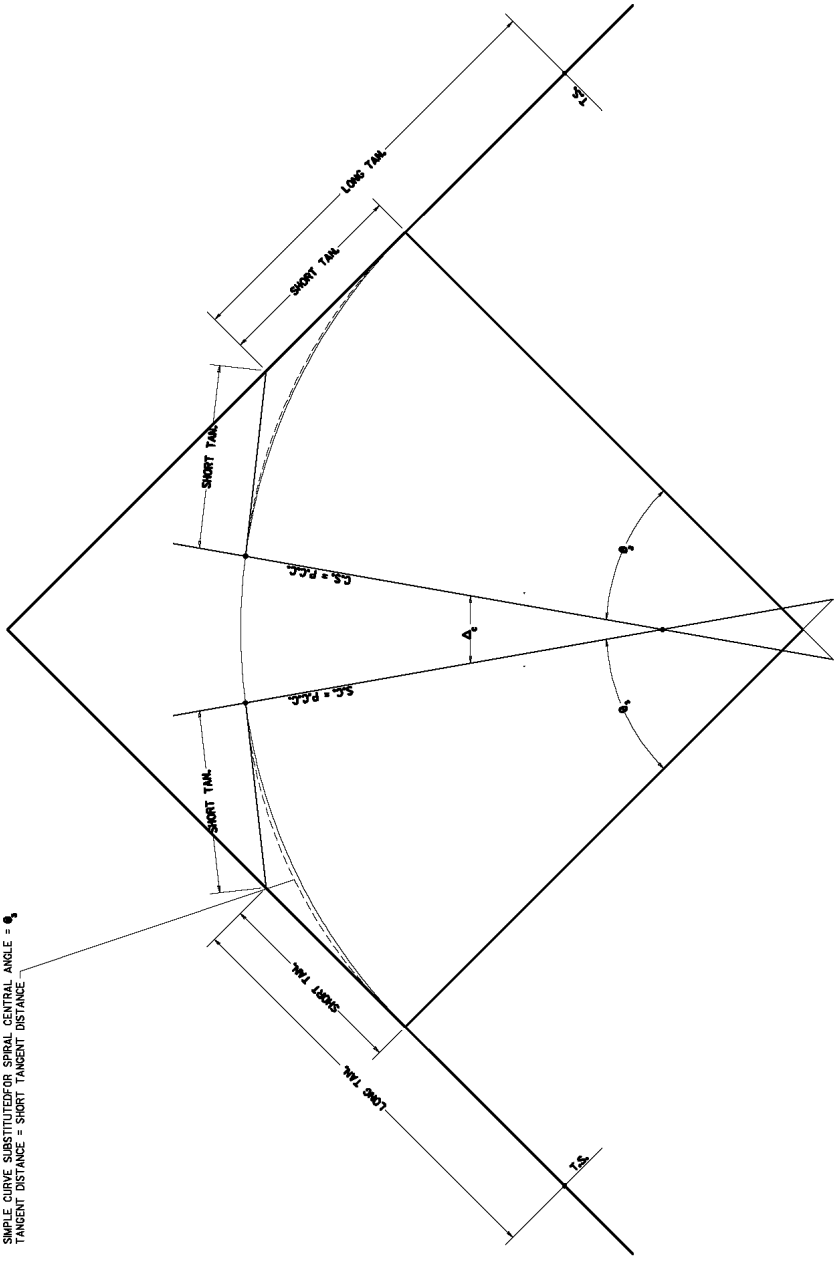
Bridges on spiral alignments represent a special case. In no case shall a bridge be constructed on a spiral. Bridges falling into areas of spiral highway alignments, shall be laid out using one of the following two methods.

1. A working line can be established, which is tangent to the spiral at some point, generally near the center of the bridge. The ordinate is then determined using the length of bridge between centerlines of abutment bearings. If this ordinate is less than 1 foot (1'-0") then the bridge can be laid out as described above for simple curves. Careful selection of the point of tangency for the working line is important. This may involve some trial and error.

2. A substitute base line can be established which will replace the spiral in the area of the bridge with a simple curve or a series of simple curves. The substitute base line will be offset somewhat from the original spiral alignment but for short spirals into relatively flat curves, this offset will not significantly alter the location of the bridge.

   The substitute base line is set up by replacing the spiral with an extension of the original tangent and a curve of constant radius. The spiral to curve (S.C.) point then becomes a point of compound curvature. The calculations for this substitute base line are such that the central angle of the curved portion of the substitute base line equals the θ_s of the spiral and the radius equals the short tangent of the spiral divided by the tangent function of one half of the central angle. The length of the tangent portion of the substitute base line equals the difference between the long and short tangents of the spiral.

   The following diagram shows the suggested method for substituting a constant radius curve for a spiral. The simplicity of this method is offset by the fact that for long spirals into relatively sharp curves, the substitute base line may fall a few feet outside the spiraling alignment. For a spiral 600 feet long going into a curve of 16 degrees the substitute base line falls a maximum of about 10 feet outside of the spiral. When large offsets result (greater than 10 feet) the substitute base line should be set up as a series of compound simple curves approximating the spiral. This approximation must be determined by trial and error.



A Method of Substituting Simple Curves for a Spiral

Using the replacement alignment, the ordinate to the simple curve is determined using the bridge length between centerlines of abutment bearings. If this ordinate is less than 1 foot (1'-0"), then the bridge superstructure can be laid out straight as described above. If the ordinate is greater than 1 foot, then the bridge will have to be constructed with a curved superstructure.

Working Lines

In a case where a bridge falls on a non-tangent alignment, it will be necessary to establish a working line from which to lay out the bridge. The following cases describe the manner in which working lines are to be established. Alternate methods may be approved on a case by case basis. However, these examples are to be followed whenever applicable.

1. A bridge constructed with a curved superstructure and radial substructure units should be laid out off of the curved baseline.

2. A bridge constructed with a curved superstructure and non-radial substructure units should have its superstructure laid out off of the highway curve data in the area of the structure, and its entire substructure laid out off of a straight working line. This straight working line will generally be a tangent to the baseline at a point near the center of the bridge. All dimensions, angles and other geometric information for the entire substructure should be referenced to this straight working line.

3. A bridge constructed with a straight superstructure and non-radial substructure units should be entirely laid out off of a straight working line. Established as noted above.

It is desirable to lay out both sides of a bridge (or all four sides of a dual bridge) off of a single working line. However, it is not mandatory. There may be cases where it is necessary to establish more than one working line. The use of only a single working line is preferred.

Lane Lines

The travel lines for the highway will be striped in accordance with the highway base line curve data (either circular or spiral) through the bridge area and the shoulder widths on the bridge would vary but never be less than the minimum established by MDOT policy.

MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION	Office of Structures ***Guidelines and Procedures Memorandum***	PLANS Number: P-85-31(G) Date: 03-16-2018
	Shoulder Widths for Bridges on Non-Tangent Alignments	Approval: DRAFT

Refer to GPM D-85-25(G) for the layout of bridges on non-tangent alignments. All AASHTO references are made to *Geometric Design of Highways and Streets.*

Every bridge proposed on a non-tangent alignment shall be evaluated for sight distance. In order to properly address the sight distance needs of motorists, the following criteria for structure shoulder widths shall be used.

Sight distance on bridges shall be the distance required for stopping. For level roadway conditions, this distance (S) shall be the value from AASHTO Exhibit 3-1. For roadways on grades (downgrades or upgrades), use stopping sight distances from AASHTO Exhibit 3-2. The shoulder width required for sight distance can then be calculated from the formula HSO=R[1-cos(28.65S/R)] where HSO (horizontal sightline offset) is the distance from the sight obstruction to the centerline of the inner lane, ft; R is the curve radius for the centerline of the inside lane, ft.; S is the stopping sight distance, ft. The required Shoulder Width = HSO-½Inside Lane Width. Refer to AASHTO Exhibit 3-54 for additional commentary.

If the shoulder width developed from the above is less than the standard shoulder width, then no further consideration is necessary, i.e., use the standard shoulder width.

If the shoulder width developed from the above is greater than the standard shoulder width, then the shoulder width adjacent to the affected lane shall be increased in 6 inch increments until the sight distance criteria is met. However, in no case shall the shoulder width exceed 12 feet. When this calculation results in a shoulder width in excess of 12 feet, the radius of curvature should be increased or the design speed reduced until a 12 foot shoulder satisfies the sight distance criteria. Reduction in design speed may require a design exception.

In addition to the above, if the shoulder width required for sight distance exceeds the standard shoulder width, the following shall be satisfied.

<u>For One-Way Ramp Bridges With Curvature Moving From Right to Left</u>

When the shoulder width developed from above exceeds the standard left-hand shoulder width and a standard width shoulder is being provided on the right, then the following shall be addressed.

> If the bridge has
> (a) a DHV less than 1100 vehicles per lane and has either
> (b) a total length of over 250 feet or
> (c) a span length greater than 150 feet
>
> then the shoulder on the left-hand side shall be increased to the width of a standard right shoulder or minimum width required for sight distance, whichever is greater (not to exceed 12 feet), and the right-hand shoulder width shall be reduced to 4 feet.

If the bridge does not satisfy (a) and (b) or (a) and (c), then a standard width shoulder shall be provided on the right, and the left shoulder shall be the minimum width required for sight distance (not to exceed 12 feet).

For One-Way Mainline Bridges With Curvature Moving From Right to Left

When the shoulder width developed from above exceeds the standard left-hand shoulder width, then a standard width shoulder shall be provided on the right and the shoulder on the left-hand side shall be increased to the minimum width required for sight distance (not to exceed 12 feet).

For All One-Way Bridges With Curvature Moving From Left to Right

When the shoulder width developed from above exceeds the standard right-hand shoulder width, then a standard width shoulder shall be provided on the left and the shoulder on the right-hand side shall be increased to the minimum width required for sight distance (not to exceed 12 feet).

For Two-Way Bridges

When the shoulder width on the inside of the curve developed from above exceeds the standard shoulder width, then increase the shoulder width on the inside of the curve to accommodate sight distance criteria (not to exceed 12 feet). Shoulder width on outside of curve shall be as dictated by approach roadway section and/or bridge geometrics standard.

MARYLAND DEPARTMENT OF TRANSPORTATION — STATE HIGHWAY ADMINISTRATION	Office of Structures ***Guidelines and Procedures Memorandum***	DESIGN Number: D-85-32(G) Date:
Bridge Width (Typical Section)		Approval: DRAFT

The overall width and typical section of any new structure, replacement structure, or major rehabilitation (including deck replacement, superstructure replacement, or widening) shall be approved prior to the development of Pre-TS&L and/or TS&L plans.

The overall width and typical section shall be established by considering the following criteria:

- The minimum typical section on structures shall be 32’-0”. Written approval from the Office of Structures is required for typical sections where 32’-0” cannot be met.
- Future needs as identified by Office of Preliminary Planning and Engineering
- MDOT Policy for Bridge Width https://policymanual.mdot.maryland.gov/mediawiki/index.php?title=Bridge:_Width)
- MDOT SHA Bicycle Policy & Design Guidelines https://www.roads.maryland.gov/OHD2/Bike_Policy_and_Design_Guide.pdf
- MDOT SHA Context Driven Access & Mobility for All Users https://www.roads.maryland.gov/OC/Context_Driven-Access-and-Mobility-For-All-Users.pdf
- AASHTO Design Guides.

If the minimum widths identified in the above criteria cannot be met, a Design Exception must be applied for and approved by the MDOT SHA.

MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION	Office of Structures ***Guidelines and Procedures Memorandum***	DESIGN Number: D-85-33(4) Date: 03-16-2018
Design of Structures Using Fracture Critical Members		Approval:

The use of fracture critical members is to be avoided wherever possible. In no case shall fracture critical members be used unless the economics and absolute necessity of their use can be justified to the Director who will approve their use at the Pre-T.S. & L. stage for further development.

If a structure including fracture critical members is proposed at the Pre-T.S. & L. stage, a structure configuration, where feasible, eliminating the need for such members must also be included as one of the Pre-T.S. & L. alternates, with dollar comparisons.

If an existing structure has fracture critical elements, and major rehabilitation is contemplated, then the elimination of the fracture critical members by redesign shall be evaluated. Every effort shall be made, if structure is to be widened, etc., to minimize the need to create more fracture critical members.

When fracture critical members are used they will be clearly identified on the General Notes.

MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION	Office of Structures ***Guidelines and Procedures Memorandum***	DESIGN Number: D-87-35(4) Date: 03-16-2018
	Treatment of Existing Bridge Decks for Bridges Included in District Resurfacing Projects	Approval:

The following are alternatives to consider when approach roadways to structures are to be overlaid:

1. Procedures when a bituminous wearing surface does not currently exist on a structure:

   a. Review the General Notes of the existing plans to see if provisions have been made for future two inches of wearing surface. If the provision for future wearing surface was made, the superstructure elements (exclusive of deck) are in good condition, and if the concrete deck condition is such that its preservation is not feasible by a latex concrete overlay, then the structure may be overlaid up to the two inch thickness with hot mix asphalt (HMA).

      The existing bridge deck roadway joints and resultant exposed height of barrier on the bridge shall be evaluated for adequacy/modification based on the proposed depth of HMA overlay.

   b. If the General Notes of the existing plans do not state that provisions for a future wearing surface were provided for, then a structural rating analysis of the superstructure elements in their present condition shall be performed with the dead load of the proposed overlay. If the rating results reveal that the maximum gross weight of all the rating vehicles can be accommodated in the **inventory** stress range, the proposed HMA overlay may be permitted if the concrete deck condition is such that its preservation is not feasible by a latex concrete overlay.

      The existing bridge deck roadway joints and resultant exposed height of barrier on the bridge shall be evaluated for adequacy/modification based on the proposed depth of HMA overlay.

      If the rating analysis shows any vehicle causing stresses within or exceeding the **operating** stress range, the overlay shall be denied. The paving option for this case is to partially or entirely remove the approach pavement section and replace it. The new pavement elevations shall match the adjoining existing bridge deck elevations.

2. Procedures when a bituminous wearing surface exists on a structure:

   a. Check the current bridge deck condition rating and if it is coded a five (5) or higher, analyze the superstructure in its present condition to see if it can accommodate the proposed HMA overlay. Verification of the existing wearing surface thickness shall be made prior to the rating analysis. If the stresses do not exceed the **inventory** stress level for all the rating vehicles then the proposed HMA overlay may be permitted.

      The existing bridge deck roadway joints and resultant exposed height of barrier on the bridge shall be evaluated for adequacy/modification based on the proposed depth of HMA overlay.

If the stresses are within or exceed the **operating** stress range, the overlay shall be denied. The paving option in this case is to remove and replace the existing wearing surface in partial or full depth.

b. When a bridge deck condition rating is a four (4) or less and the bridge or bridge deck is scheduled for replacement, the structure may be overlaid with HMA if an analysis shows the structure will not exceed the **operating** stress levels for all rating vehicles. The HMA overlay shall be saw cut along the center line of the bridge roadway joints. Prior to placing the overlay, an appropriate debris shield shall be placed between girder or stringer flanges in spans over roadways, sidewalks, railroads, etc. until the deck or structure is replaced.

The requirement for increased inspection frequency to annually, based on the structure being in the **operating** stress range, may be waived if approved by the Deputy Director of the Structure Inspection and Remedial Engineering Division.

c. When a bridge deck condition rating is a four (4) or less, <u>not</u> scheduled for bridge or deck replacement, and falls within the operating stress range for any rating vehicle with the proposed HMA overlay, the overlay shall be denied. If the bridge wearing surface is in need of refurbishing, the paving option in this case is to remove and replace the existing wearing surface in partial or full depth. Prior to removing the existing wearing surface, an appropriate debris shield shall be placed between girder or stringer flanges in spans over roadways, sidewalks, railroads, etc. until the deck or structure is replaced. Patching of the deck may be required but keep to an absolute minimum prior to placing the new HMA overlay.

MARYLAND DEPARTMENT OF TRANSPORTATION — STATE HIGHWAY ADMINISTRATION	Office of Structures ***Guidelines and Procedures*** ***Memorandum***	DESIGN Number: D-87-38(4) Date: 04-16-2019
Guide to Location of Fixed and Expansion Bearings and Selection of Roadway Joints		Approval: DRAFT

Every effort shall be made to minimize the number of bridge roadway joints. It shall also be the goal of all designers to set up the fixed/expansion bearing system in a way that provides a fixed bearing at the low end of the bridge with expansion bearings at all other substructure units. The following list prioritizes the preferred arrangements for roadway joints and fixed bearings:

1. Place the fixed bearing at the low end of the bridge following appropriate structural details. Place expansion bearings at all other substructure units. Place the appropriate expansion joint at the uphill abutment.

2. If the total length of bridge is too long or skew angle/length combination too severe to be accommodated by the 6" compression seal, that is item 1 above will not satisfy, investigate locating the fixed bearing at a pier near the center of the bridge and placing expansion bearings at all other substructure units. Place the appropriate expansion joints at both abutments.

3. If the length of bridge contributing to expansion in either direction is too long or skew angle/length combination too severe to be accommodated by the 6" compression seal, that item 2 above will not satisfy, investigate locating the fixed bearing at the low end of the bridge and providing expansion bearings at all piers and the uphill abutment. Place a 1 3/4" compression seal at the low end abutment and provide a finger type joint at the uphill abutment.

4. If the length of bridge contributing to expansion is too long to be accommodated by a finger joint at the uphill abutment and a compression seal at the low end abutment, that is item 3 above will not satisfy, investigate locating the fixed bearing at a pier near the center of the bridge and placing expansion bearings at all other substructure units. Place a finger joint at one or both abutments. It may not be necessary to use finger joints at both abutments with this arrangement. If possible, the use of a finger joint at one abutment and a compression seal at the other is preferable.

If none of the above cases can be satisfied and roadway joints are required at piers, then each section of bridge between joints will be evaluated for roadway joints following the prioritized list appearing in items 1 through 4 above.

Exceptions to this system must be clearly presented for approval at the T.S.& L. stage of review.

MARYLAND DEPARTMENT OF TRANSPORTATION — STATE HIGHWAY ADMINISTRATION	Office of Structures ***Guidelines and Procedures*** ***Memorandum***	DESIGN Number: D-89-40(4) Date: 03-16-2018
	Design Loading for Structures	Approval:

I. All components of new highway structures shall be designed to accommodate the AASHTO HL-93 loading as prescribed in the AASHTO LRFD Bridge Design Specifications.

II. All structures shall be designed to accommodate additional loadings of 25 pounds per square foot for a future 2" wearing surface and 15 pounds per square foot when the use of steel stay in place bridge deck forms are required.

III. When rehabilitation work is to be done to an existing structure that involves replacement of the deck, then that structure must be evaluated for the above loading condition. If this loading condition is not satisfied then the following sequence of analyses must be done. A chart summarizing the analysis steps with load ratings of the different options should be submitted for review to the Office of Structures.

A. If the structure is a non-composite design, then it must be analyzed by making it a composite design to try to meet the new loading conditions.

B. If (A) above does not satisfy the loading conditions then the structure must be analyzed by reducing the 15 pounds per square foot for steel stay in place bridge deck forms to 9 pounds per square foot. The Plans must specify that the form troughs must align with the transverse rebar spacing.

C. If (A) and (B) above do not satisfy the loading conditions then the structure must be analyzed without the future 2" wearing surface.

D. If (A) through (C) above do not satisfy the loading conditions then the structure must be analyzed by eliminating the 9 pounds per square foot for steel stay in place bridge deck forms. The Plans must specify that wood forms must be used on the deck's underside.

E. If (A) through (D) above do not satisfy the loading conditions then the structure must be analyzed using lightweight concrete. The use of steel stay in place bridge deck forms and a future wearing surface should be reconsidered here.

F. If (A) through (E) above do not satisfy the loading conditions then direction from the Office of Structures should be requested before proceeding further.

IV. All new pedestrian structures shall be designed for 85 pounds per square foot live load and 15 pounds per square foot for the use of steel stay in place bridge deck forms, if applicable.

V. All new or rehabilitated vehicular superstructures shall be rated according to the procedure dictated in GPM No. D-97-47(4). The rating shall be used to report the National Bridge Inventory.

VI. Existing Structures:

Refer to GPM No. D-97-47(4) – Structural Load Ratings

MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION	Office of Structures ***Guidelines and Procedures*** ***Memorandum***	DESIGN Number: D-94-45(4) Date: 08-15-2019
Proprietary Noise Barrier Approval Process		DRAFT

In order for a proprietary noise barrier system to be considered for use on MDOT SHA right-of-way, the barrier system must be on the list of Approved Proprietary Noise Barriers maintained by the Office of Structures and posted on the Administration's website (www.roads.maryland.gov). All proprietary noise barrier systems must go through a five (5) step approval process prior to inclusion on the list. It should be noted that the inclusion of a noise barrier system onto the Approved Proprietary Noise Barrier list does not guarantee that it will be used on any MDOT SHA project. In addition, a system will only be used on projects where it is reviewed and approved by the Administration prior to advertisement and is specified in the Contract Documents.

All proprietary noise barrier systems shall use caisson foundations designed by MDOT SHA or their design consultant, unless otherwise approved by MDOT SHA. The caisson schedule will be provided in the contract documents.

It should be noted that the approval of a noise barrier system does not extend to approval of precast plants or to the approval of the materials to construct the wall. All precasters and materials used on MDOT SHA projects must be approved by MDOT SHA's Office of Materials Technology prior to use.

The approval process for selection and placement on the approved list is as follows:

Step 1 - Request For Inclusion

A supplier or his representative requests in writing to the Director of the Office of Structures and the Office of Highway Development's Noise Abatement Team the desire to be placed on this list. The request must include enough information for the Administration to make a determination based on the following points:

- The supplier demonstrates that they are a large enough operation to supply the necessary wall components to a Contractor in the needed turnaround time.
- The system has a sound theoretical and practical basis for the engineers to evaluate its claimed performance.
- The system presents an aesthetically pleasing appearance.
- Past experience in construction and performance of the proposed system.

Step 2 –Noise Barrier System Information

Should the noise barrier system be accepted for consideration, the supplier or his representative must submit a package which includes and satisfactorily addresses the following items:

A. The system theory and the year it was first used;

B. Practical applications with descriptions and photos. Direction to a manufacturer's website containing this information is acceptable.

C. Limitations and disadvantages of the system;

D. Any known failures of the system, including where, how and why it failed. If applicable, include information on how the system was repaired;

E. List of users (other states, counties, etc.) including contact names, addresses and phone numbers;

F. Details of noise barrier elements, analysis of structural elements, design calculations, factors of safety, estimated life, corrosion design procedure, procedures for field and laboratory evaluation including instrumentation and special requirements, if any;

G. Sample material and construction control specifications—showing material type, quality, certifications, field testing, acceptance and rejection criteria and placement procedures;

H. A well documented field construction manual describing in detail, with illustrations where necessary, the step by step construction sequence and any special equipment required. The document shall also include repair procedures;

I. Typical unit costs, supported by data from actual projects.

Step 3 – Design Evaluation

If, after evaluating this material, MDOT SHA finds it acceptable, the supplier must have the total system reviewed by an independent professional engineer, registered in Maryland, and acceptable to this Office. A list of professional engineering firms acceptable to this Office is available upon request. If the supplier selects an engineering firm who is not on the list, the name and qualifications must be submitted to this Office for approval.

The independent professional engineer shall, at no expense to MDOT SHA, review the design concepts, specifications, calculations, construction specifications, for compliance with AASHTO and SHA criteria. If the independent, professional engineer finds the barrier system meets AASHTO and SHA criteria and so documents in writing, the barrier will then be evaluated for aesthetics and constructability. The independent professional engineer shall stamp the design calculations and plans indicating that they have been reviewed and found to be acceptable. A copy of the stamped calculations and plans will be kept on file.

The design of the proprietary noise barrier system must follow the current AASHTO Specifications. Design calculations should clearly indicate the date of the specifications and interims used in the wall design.

A two-degree rotation of panels and posts at the top of the foundation (caissons) shall be assumed and the additional moment caused by dead load shall be considered.

If the proposed system contains a restrained panel, it shall be reinforced for the additional forces caused by the panel restraint.

Step 4 – Aesthetic Evaluation

For this evaluation, the supplier shall, at no expense to MDOT SHA, furnish and erect a sample barrier at MDOT SHA's Office of Traffic and Safety in Hanover, Maryland. Plans for posts and foundations which are available at this site may be obtained from the Office of Highway Development's Noise Abatement Team. The date of the sample barrier erection must be coordinated with the Office of Structures and the Office of Highway Development's Noise Abatement Team. The sample barrier shall remain erected for two weeks, unless directed otherwise by MDOT SHA, and then be removed by the supplier, at no expense to MDOT SHA. In lieu of the sample barrier, the supplier may provide the location of an actual noise barrier in service within 100 miles of the city of Baltimore. This wall must be of the same design and surfacing as the barrier proposed for consideration.

Once all of the above criteria and evaluations are successfully met, the barrier will be added to the approved list, and considered for use at locations deemed appropriate by MDOT SHA, based on aesthetics, economy, design requirements and constraints, etc.

Step 5 – Submittal of Standard Details

Once a noise barrier system is on the approved list, the noise barrier firm shall provide standard details and specifications showing panels, posts, reinforcements, materials, repair details, etc., for review and approval. Once approved by the Office of Structures and the Office of Highway Development, they will be stamped and kept on file along with a copy of the design calculations. For Contracts in which the system is selected, the barrier firm shall submit construction plans, etc. using only the approved details and specifications that are on file. Shop drawing review will be based on these details.

For information on what is to be included in the advertised contract documents, see GPM No. P-93-37(4), Contract Documents for Noise Barriers.

Revisions to Approved Proprietary Noise Walls

Should any detail, specification, etc. change during the time it is on the Approved Proprietary Noise Barrier list, the barrier firm must submit the revision for review and approval, prior to using that revision on MDOT SHA projects. Revisions may not be submitted for projects which are already bid.

Approval Expiration

The approval of a noise barrier system is good for 10 years from the date of acceptance. To have the noise barrier system approval renewed, the noise barrier system representative must request in writing to the Director of the Office of Structures indicating any changes to the barrier system since the prior approval. An evaluation as outlined in Step 3 may be required.

The Administration reserves the right to remove a noise barrier system from the Approved Proprietary Noise Barrier list at any time.

MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION	Office of Structures ***Guidelines and Procedures Memorandum***	INSPECTION Number: D-97-47(4) Date: 08-10-2018
	Structural Load Ratings	Approval:

All highway bridges in Maryland shall be load rated for both inventory and operating stress levels. As a minimum for ratings performed by SHA staff, all ratings shall be performed by a load rating engineer and checked by another engineer with experience in load ratings. The load rating engineer shall be a graduate engineer. The engineer checking the rating shall be a graduate engineer and be PE eligible. The Division Chief in charge of the load rating program shall be a Professional Engineer.

As a minimum for ratings performed by an engineering consultant firm, all ratings shall be performed by a load rating engineer and checked by another engineer with experience in load ratings. The load rating engineer shall be a graduate engineer. The engineer checking the rating shall be a professional engineer licensed in Maryland. P.E. Stamped load rating calculations and supporting data shall be submitted to the Deputy Director, Office of Structures – Remedial and Inspection Engineering for review and documentation.

For new bridges, the load rating shall be performed when the final design is complete. The load rating shall appear on the advertised plans. This load rating shall be revised, if necessary following construction of the bridge, to account for any changes to the structure as the result of addendums, red line revisions and as-built revisions. The rating methodology to be used for rating a new bridge shall be consistent with the design methodology used in the design of that bridge. Since all new bridges designed after October 2007 are required to be designed by the AASHTO Load and Resistance Factor Design (LRFD) method, all bridges designed by this methodology shall therefore be rated using the AASHTO Load and Resistance Factor Rating (LRFR) method.

For existing bridges which are undergoing a major rehabilitation and not designed by LRFD method, the load rating or re-rating shall utilize the Load Factor Rating (LFR) method. The only exception to this is for timber and masonry bridges, which shall continue to be rated using the Allowable Stress Rating (ASR) method.

All ratings, both in house and by Consultants, shall be performed using the LARS program. If the LARS program is not capable of providing an accurate rating, then a request to utilize another program shall be submitted in writing to the SHA Division Chief in charge of load ratings or the County/Local Agency Program Manager. All final load rating computer files shall be submitted to SHA Division Chief in charge of load ratings for storage.

For SHA bridges, a re-evaluation of the current bridge load ratings shall be done for all bridge inspections that result in an Engineering Request. (An Engineering Request is a request made by a field inspector to have a structural engineer perform a field inspection of a bridge element(s). The requests are usually associated with deleterious changes to a bridge element(s) since the last inspection.) This re-evaluation may necessitate new bridge load ratings being established. This evaluation must be documented for each Engineering Request and shall include the date of the evaluation, who performed and checked the evaluation, and the reasons behind the decision to perform a new load rating or not. Any required load rating shall be given a “P” priority, shall be completed within 6 months of receipt, and rated utilizing the Load Factor Rating (LRF) method. (The Structural Inspection and Remedial Engineering Division uses a job priority scale consisting of E, P, A, B, C, and D with

"E" emergency being the top priority and "D" being the lowest priority.) The only exception to this is for timber and masonry bridges, which shall continue to be rated using the Allowable Stress Rating (ASR) method.

For County/Local Agency bridges, an evaluation based on criteria contained in this GPM of the existing ratings on all bridges shall be performed to ensure the current condition is reflected in the current rating. This evaluation shall be documented as part of each new inspection report.

All load rating computations shall be completely documented, scanned, and inputted into the SHA Structure Asset Management (SAM) program for future reference. The document must include inspection reports and all calculations with support material such as rating assumptions, controlling members and the condition they were assumed to be in, material properties and load test data if available. The required methodology for rating of highway structures is summarized in the table below.

ORIGINAL DESIGN OR MAJOR REHABILITATION SPECIFICATION USED	EXISTING RATING	LOAD RATING OR RE-RATING METHODOLOGY
Load and Resistance Factor Design (LRFD)	None or	LRFR
	Load and Resistance Factor Rating (LRFR)	LRFR
Load Factor Design (LFD) or Allowable Stress Design (ASD)	None or	LFR
	Allowable Stress Rating (ASR) or	LFR
	Load Factor Rating (LFR)	LFR
Combination of Specifications (LRFD, LFD, ASD) or Unknown	None or	LFR
	Allowable Stress Rating (ASR) or	LFR
	Load Factor Rating (LFR)	LFR
ASD for Existing Timber and Masonry Bridges	None or ASR	ASR

Structural Load Ratings

Load and Resistance Factor Rating (LRFR) Procedure:

Rating shall follow the latest edition of the AASHTO "The Manual for Bridge Evaluation" (MBE) Section 6, Part A. The rating shall be reported as a factor for the HL-93 vehicle and tons for all other rating vehicles.

The HL-93 vehicle is the Design Load Rating Vehicle. The Legal Load Rating Vehicles shall be rated and recorded as an Operating Rating. No Inventory Rating shall be recorded. The Permit Load Rating Vehicles shall be rated in accordance with the Permit Load Factors shown in the MBE Table 6A.4.5.4.2a-1 for the Routine or Annual Permit Type. No Inventory Rating shall be recorded.

If the Inventory Rating factor for the HL-93 vehicle is less than 1.0, or the Operating Rating of the Legal Load Rating Vehicles is less than the vehicle weight, the Deputy Director – Structural Inspection and Remedial Engineering shall be notified in writing within three (3) work days of completion of the load rating calculations that indicate the potential need for a posting situation and a recommendation of what the posting should be. The notification shall include the load ratings for all legal vehicles and the same ratings using other rating methods such as ASR or LFR for comparison. The notification should also provide ratings for site specific vehicles such as local business and emergency vehicles. The Deputy Director shall respond to the notification in writing within seven (7) days of receiving the notification. If a response is not received within seven (7) days, a follow up email shall be made to the Deputy Director asking for a response to the potential posting situation.

Load Factor Rating (LFR) Procedure:

Rating shall follow the latest edition of the AASHTO "The Manual for Bridge Evaluation" Section 6, Part B. The rating shall be reported in tons calculated for each of rating vehicles except for the HL-93 loading.

If the operating rating is less than any of the Legal Load Rating Vehicles' weight, the Deputy Director – Structural Inspection and Remedial Engineering shall be notified in writing within three (3) work days of completion of the load rating calculations that indicate the potential need for a posting situation and a recommendation of what the posting should be. The notification shall include the load ratings for all legal vehicles and the same ratings using other rating methods, such as ASR or LRFR for comparison. The notification should also provide ratings for site specific vehicles such as local business and emergency vehicles. The Deputy Director shall respond to the notification in writing within seven (7) days of receiving the notification. If a response is not received within seven (7) days, a follow up email shall be made to the Deputy Director asking for a response to the potential posting situation.

Load Rating for the Serviceability Limit State:

Load ratings shall not include serviceability computations, unless the bridge has specific concerns related to serviceability such as unusual deformation or cracking. Generally, an existing bridge with a successful performance history will not require a serviceability evaluation. SHA must be notified for concurrence before considering serviceability in a load rating.

Bridges with Unknown Structural Components:

For bridges where necessary information is unavailable, such as concrete or masonry bridges with unknown structural details, an approximate load rating may be established through an evaluation by a qualified engineer, with the following guidelines:

- If the structure has been carrying normal traffic for an appreciable period of time, and the current field conditions indicate no signs of structural distress from loads, the inventory and operating rating factor for each legal vehicle may be taken as 1.0, and the ratings for the permit vehicles shall be left blank.
- If the engineer determines that the structure shows signs of distress or otherwise feels that engineering judgment should not apply, the SIRED will be notified and an assessment will be made regarding the need for posting, load testing or repair.

Concrete Culverts:

For concrete culverts under at least 2.0 ft of fill, whether there are known structural details or not, a load rating may be established through an evaluation by a qualified engineer. This engineering judgment rating is acceptable if the structure has been carrying normal traffic for an appreciable period of time and the current condition is fair or better with no signs of structural distress. Under these conditions, the inventory and operating rating factor for each legal vehicle may be taken as 1.0, and the ratings for the permit vehicles shall be left blank.

Proof Load Test Ratings:

When lack of plans and/or inability to achieve a reliable computational rating cannot be achieved, then a proof load test may be required. Any bridge that has a successful proof load test shall have the inventory and operating ratings indicated in tons for those vehicles. For example, the T-4 rating would be 35 Tons Inventory and 35 Tons Operating. In addition, any of the other rating vehicles that can be shown to induce lower stresses than the proof load vehicle, the inventory and operating ratings can indicate the tons of the vehicles. For example, if the HS20 vehicle induces lower stresses than the T4, then the HS20 ratings would be 36 Tons Inventory and 36 Tons Operating. Those

vehicles that cannot be shown to induce lower stresses than the proof load vehicle shall be restricted from crossing the bridge.

Live Load Distribution Factors:

For all bridges on Interstate Routes and any other bridge carrying an ADT of 20,000 or greater, both the legal and the permit vehicles shall be rated using multi-lane distribution factors. For all other bridges, multi-lane distribution factors shall be used for the legal vehicles, and a "modified distribution factor" shall be used for the permit vehicles. The "modified distribution factor" is to be calculated as the average of the single-lane distribution factor and the multi-lane distribution factor.

For permit vehicles on bridges with an ADT of 20,000 or greater, the "modified distribution factor" may be used if there are only two lanes of traffic on the bridge with one lane in each direction. This "modified distribution factor" shall not be used on two lane bridges with an ADT of 20,000 or greater where both lanes are in the same direction.

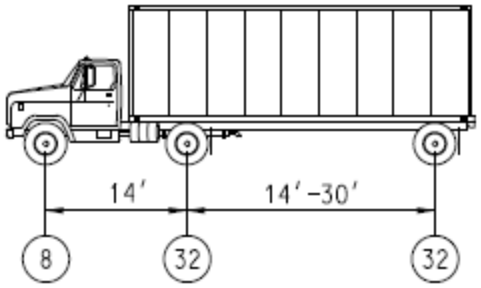
Rating Vehicles:

All bridges are to be rated for each of the legal and permit vehicles described in the following section. Note that the AASHTO Manual for Bridge Evaluation describes a set of Specialized Hauling Vehicles (SHV's) which are single-unit trucks that are legal in Maryland. However, these vehicles have been determined to have a low probability of affecting any posting requirements that would result from rating these vehicles. Because the Maryland Type 3 and Type 4 trucks adequately govern the posting requirements for single-unit vehicles, the AASHTO SHV's are not required to be evaluated.

RATING VEHICLES

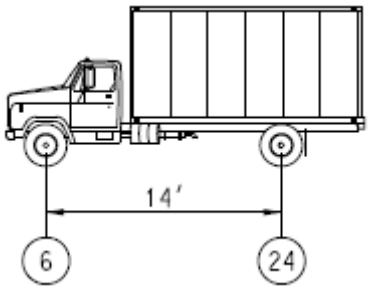
(All numbers in circles are axle loads in 1,000 lbs i.e. ⑧ – 8,000 lb axle load)

LRFR Design Vehicle (Non Permit Load rating):



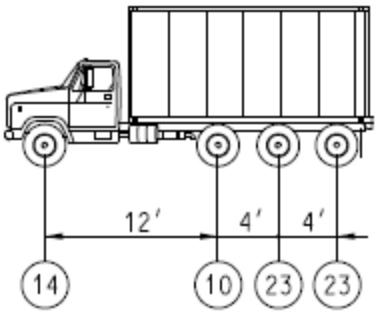
HL-93 (SIA Items 401 and 402)
72,000 pounds include AASHTO Lane Load and tandem where applicable
(If the LRFD method was used in the design of the structure)

Legal Load Rating Vehicles:

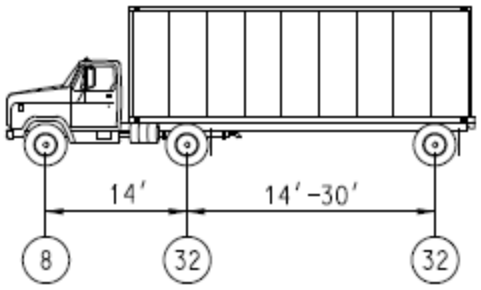


H-15 (SIA Items 403 and 404)
30,000 pounds

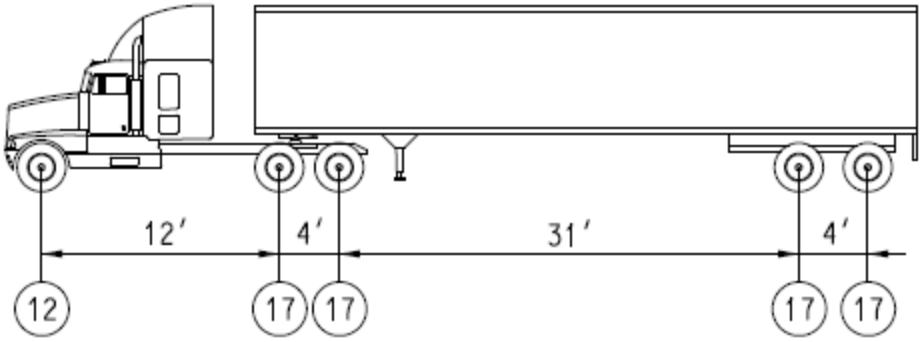
Structural Load Ratings



Type 4 – Reduced Lift Axle (10 kips maximum on lift) (SIA Items 407 and 408)
70,000 pounds

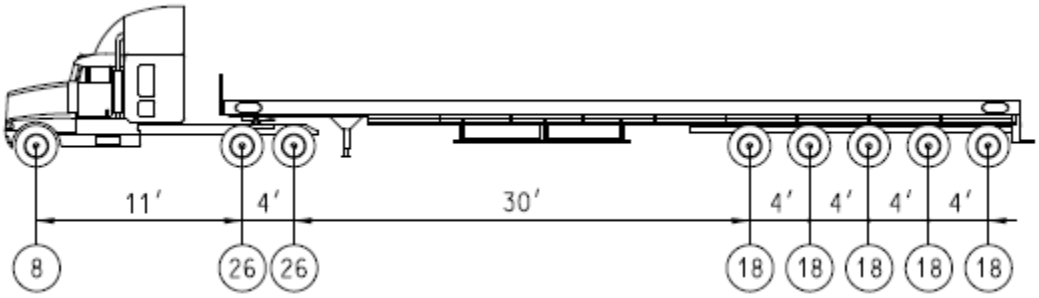


HS-20 (items 409 and 410)
72,000 pounds
(Evaluation not required if HL-93 is rated)



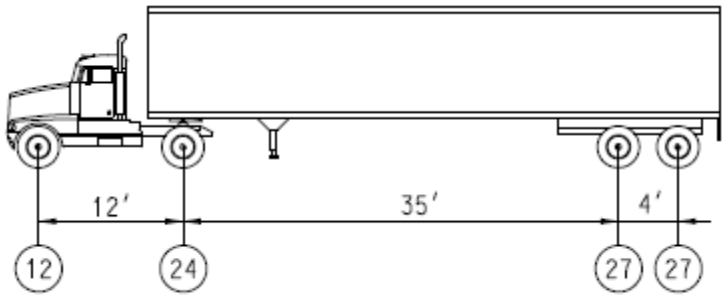
3S2 (SIA Items 411 and 412)
80,000 pounds

Permit Load Rating Vehicles:

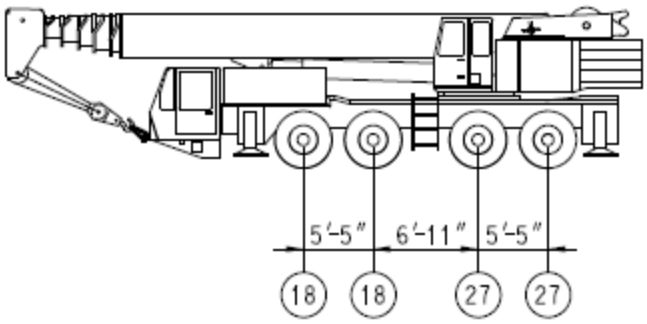


150,000 pound Vehicle (SIA Items 413 and 414)

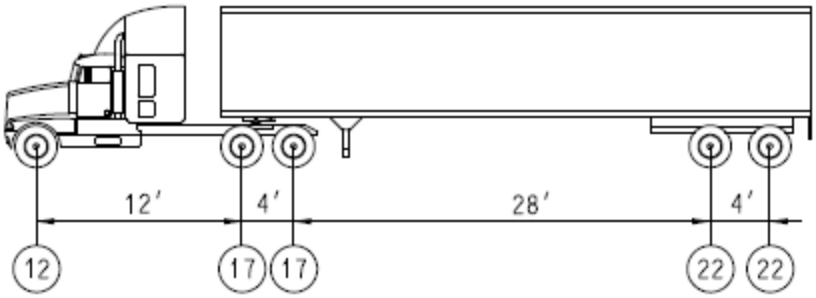
Permit Load Rating Vehicles - continued:



90,000 pound Permit Combination Vehicle (SIA Items 415 and 416)

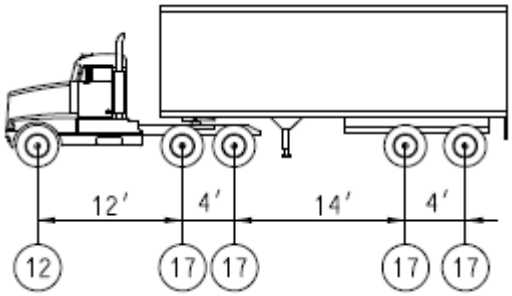


90,000 pound Mobile Crane Vehicle (SIA Items 417 and 418)

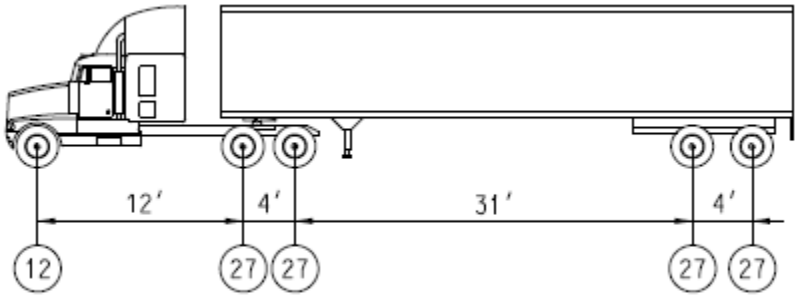


90,000 pound Cargo Vehicle (SIA Items 419 and 420)

Permit Load Rating Vehicles - continued:

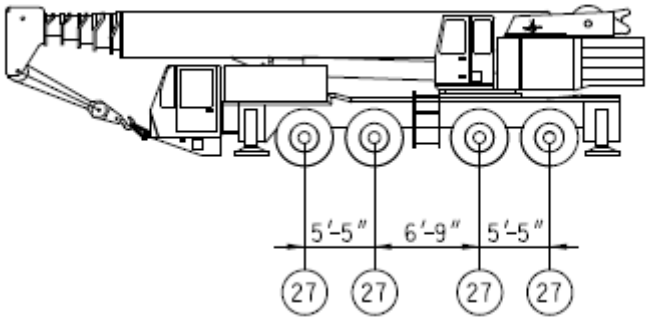


80,000 pound Cargo Vehicle (SIA Items 421 and 422)

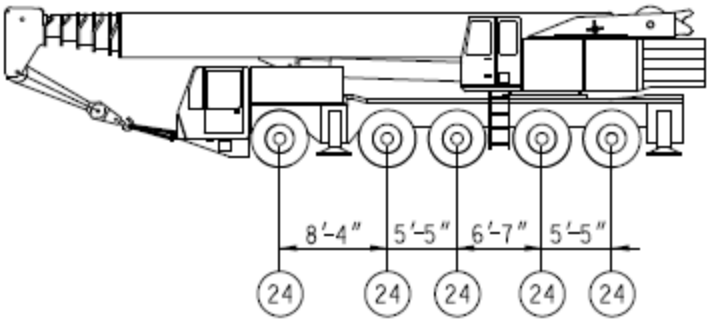


120,000 pound Combination Vehicle (SIA Items 423 and 424)

Permit Load Rating Vehicles - continued:



108,000 pound Mobile Crane Vehicle (SIA Items 425 and 426)



120,000 pound Mobile Crane Vehicle (SIA Items 427 and 428)

MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION	Office of Structures ***Guidelines and Procedures Memorandum***	DESIGN Number: D-99-48(4) Date: 03-16-2018
	Establishing Scope of Work for Structure Rehabilitation Projects	Approval:

Whenever design studies are begun that involve an existing structure (deck replacement, superstructure replacement, major rehabilitation, etc.), a full evaluation of the condition of the existing structure and the constraints associated with structure rehabilitation must be made as early as possible so that the project can be properly scoped. All deteriorated elements and problem details (expansion joints over piers, longitudinal joints in the travel lanes, converting simple spans to continuous, etc.) that may cause premature deterioration must be addressed. The following steps should be investigated at the beginning of all rehabilitation projects to minimize the need for increasing the scope of the project as we near the advertising stage.

- Review the latest inspection reports.
- Make a field visit to the site to perform a structure inspection as described in GPM D-84-28(4).
- Review the bridge with SIRE personnel and include any recommended remedial repair or painting in the rehabilitation contract.
- Review the bridge with the Structure Hydrology and Hydraulics personnel and include any recommended scour countermeasures.
- Contact Project Planning to determine if additional lanes etc. are required for present or future traffic needs.
- Contact District to get their input into the scope of work required.
- Contact the District Traffic Engineer to discuss what options for maintaining traffic shall be investigated as part of the Maintenance of Traffic Alternate Analysis. The ideal maintenance of traffic scheme for ease of construction is a detour away from the construction area. This could include routing traffic (vehicles and/or pedestrians) over a temporary bridge during construction. In lieu of a detour, the minimum number of lanes and lane width that must be maintained across the structure during the construction phase should be agreed upon at this stage. Determine any requirements that may restrict the Contractor (work at night, temporary lane shut downs, summer construction, incentive/disincentive, etc.) so that the budget and Ad date can be adjusted/set to reflect.
- Determine if the bridge has functional concerns. If it does, determine how the bridge must be rehabilitated to eliminate any functional concern.

- When traffic must be maintained across the bridge, set lane widths and construction gaps to meet the minimum requirements set by the district. Allow for lap splicing of reinforcing steel between stages of construction (in lieu of mechanical reinforcing steel couplers or bent rebars). Avoid single lane splits whenever possible.

- Evaluate the affect of staged construction on emergency vehicles, school buses, businesses etc. and coordinate any impacts through the District. If traffic must be maintained on approach shoulders, request shoulder corings to determine if the shoulders are sufficient to handle traffic. If the shoulders are not sufficient, the shoulders may need to be rebuilt as a first order of work.

- Find out if the lab has recently completed a structure condition survey. If not, request one to determine the extent of chloride intrusion and concrete deterioration. In areas where the lab reports sound concrete with high chloride content, consider chloride extraction as an alternative to complete removal and replacement of that element.

- For bridges with multiple simple spans, look at making the structure continuous for live load and eliminate the joints and seals over the pier(s). This may also include bearing modifications to allow the bridge to move properly (refer to GPM D-87-38(4)). A chart shall be prepared which clearly shows the effects the continuity will have on the existing stringers and substructure units. Cost data should be included in the chart and must include cost for bearings, continuity connections, etc. If the structure has kinked girders at the support, no effort shall be made to make the structure continuous. If the structure has many spans then as many spans as possible shall be made continuous. Drainage troughs shall be added under all deck joints as part of the deck replacement.

- Designers should also evaluate an alternative for a superstructure replacement. In some cases it may be cost effective to do a superstructure replacement in lieu of a deck replacement with cleaning and painting of structural steel with an existing lead based paint system on it. This is almost always the case if the stringers are going to be taken down to do any work on the substructure units.

- Evaluate the loading conditions as described in GPM D-89-40 (4).

- Evaluate the existing substructure's ability to carry the proposed loading condition in both the final condition and the conditions developed through staged construction. These loading conditions must be compared to the loading condition for which the bridge was designed.

- Evaluate the approach traffic barrier and attachments to the structure and make the necessary modifications or replacement to bring the end treatments up to the latest safety standards. For bridge deck replacements our standards for new construction should be used.

- Request field surveys to verify key dimensions in the as built geometry of the existing structure. Refer to GPM D 84-28(4).

- Evaluate the constructability of the proposed scheme prior to submitting for TS&L to ensure that what is being proposed can be built; amount of sheeting, wetlands, construction access, temporary support of pier caps, etc.

- As an alternative to any scheme developed following the above criteria, evaluate the extent to which the existing bridge must be widened, have its alignment shifted or use mechanical couplers (sub and super) in lieu of reinforcing steel laps, to eliminate a stage of construction. It may be more cost effective to do a small bridge widening in conjunction with the rehabilitation if it eliminates a stage of construction, and results in additional bridge width that may be utilized to improve acceleration lanes, shoulder widths, etc.

- Evaluate the utility situation with respect to what is on the bridge, what needs to be maintained on the bridge, what will be affected near the bridge- especially relative to any pile driving required.

MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION	Office of Structures ***Guidelines and Procedures Memorandum***	DESIGN Number: D-11-49(4) Date: 03-16-2018
Deck Reinforcement for Bridges with Multiple Girder/Beam Spacing		Approval:

Care shall be taken to address the location of truss bar bend points and the number and location of the longitudinal bars in the deck slab for bridges with varying girder/beam spacing. This situation typically occurs on a deck replacement project that includes a widening. The tendency in this situation has been to specify the standard deck slab for the largest girder/beam spacing.

Using this method creates a problem in the smaller spaced spans because the top bend point of the truss bar specified for the wider spacing causes the “belly” dimension of the truss bar to be too small to cover the necessary positive moment area. In addition, this results in the improper spacing and location of the longitudinal bars.

To ensure the proper placement of the deck reinforcement, include both a plan and section view of the deck slab on the bridge typical section plan sheet. The detail shall be developed in accordance with the standard detail that applies to a particular spacing. The detail needs to show the layout of the truss bar across each girder/beam spacing, the distribution and location of the longitudinal steel for each girder/beam spacing, and the layout of the reinforcement at any staged construction joint if applicable.

MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION	Office of Structures ***Guidelines and Procedures Memorandum***	DESIGN Number: D-12-50(4) Date: 03-16-2018
	Structural Design Quality Control	Approval:

The following procedures shall be used to ensure that the structure projects we advertise meet the latest structural design requirements and are economical.

1) All Structural Reviews submitted to MDOT SHA by consultants shall have a complete check of the work by the Prime Consultant. This includes all design work prepared by subconsultants under the Prime Consultants agreement with MDOT SHA. The Prime Consultant shall indicate in writing to MDOT SHA that such a review has been made and the Prime Consultant agrees with the design as presented on the Structural Review Plans.

2) All structures designed in-house or by consultant shall be subjected to an independent design check (IDC) by another consultant.

An IDC shall take place after the designer has addressed all of MDOT SHA's Structural Review comments. The plans shall be provided to an independent reviewer, assigned by MDOT SHA. The review shall consist of a total check of the design of the main members, including superstructure, piers, abutments and foundations, including any stage construction configurations which differ from the final configuration. The scope of the IDC on structure widening, superstructure replacement, and deck replacements shall be established at the time of review but need not include a full check of all existing bridge elements to remain in place.

This IDC will be made by a Professional Engineer experienced in structural design and licensed in Maryland. For both in-house and consultant bridge designs, the IDC shall be made by a consultant who has had no previous involvement with design of any structural element in the project. When a subconsultant prepares the structural design or any portion of the structural design, then the Prime consultant's review of the structural design does not satisfy the requirement of an IDC.

The results of this IDC will usually result in one of three outcomes:

1) the design is acceptable as-is
2) elements are significantly over-designed (Exceed AASHTO and OOS requirements)
3) elements are under-designed. (Do not meet AASHTO and OOS requirements)

The results of this IDC shall be documented, compared to the original design and any discrepancies and recommendations for changes noted. The results shall be provided to the OOS project manager for their review and comment or in the case of a consultant design, the OOS project manager shall forward the results to the Prime Consultant for review and comment.

If the Prime Consultant and Checker cannot resolve differences relative to the IDC, then MDOT SHA shall provide a third party to settle the dispute.

If the bridge is determined to be acceptable as-is, then the cost of the IDC shall be the responsibility of the MDOT SHA. If the structure is under-designed, necessary changes shall be made to the contract documents to bring them into minimum AASHTO and OOS compliance as to design requirements. If the structure is over-designed and significant cost savings can be achieved by modifying the design, then these modifications shall be implemented. For consultant projects, any such changes to correct under / over-design to an acceptable level shall be made to the contract documents at no additional cost to MDOT SHA. The documented cost for an IDC that shows either an under design or significant over design shall be reimbursed to MDOT SHA by the Prime Consultant.

This policy may be waived for portions of design that consist of MDOT SHA standard elements such as parapets, deck slabs and prestressed concrete planks. MDOT SHA shall be the sole judge of the scope of services for the IDC.

MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION	Office of Structures ***Guidelines and Procedures*** ***Memorandum***	DESIGN
		Number: D-18-51(4)
		Date: 03-16-2018
	Reinforced Concrete	Approval:

The following guidelines and procedures relate to the design of bridges containing reinforced concrete and shall be used in conjunction with the AASHTO LRFD Bridge Design Specifications.

Concrete Design Strength

The design compressive strength for the following MDOT SHA Concrete Mixes shall be used in the design calculations.

Mix No. 6: f'_c = 4,000 psi
Mix No. 3: f'_c = 3,000 psi

The design strength of any proposed concrete mix shall be 500 psi less than the specified mix design strength to allow for the potential acceptance of individual strength tests below the specified strength per MDOT SHA Standard Specifications.

Grade 60 Reinforcing Steel

All designs shall be performed utilizing ASTM A-615 Grade 60 steel with an allowable f_y = 60,000 psi (f_s = 24,000 p.s.i.)

Number 14 and Number 18 Reinforcing Bars in Substructure Units

Whenever possible, substructure units shall be so designed that the largest reinforcing bar utilized will be a #11 bar. If during design it is determined that #14 or #18 bars are required, then approval in writing for their use will be required from the Director-Office of Structures before these bars are to be used in the design of the substructure.

Minimum Reinforcing Bars in Retaining Walls and Abutment Stems

AASHTO specifications require a minimum of 1/8 square inch of horizontal reinforcement per foot of height of retaining walls and abutments to resist the formation of temperature and shrinkage cracks. While this is adequate for relatively small walls, it is not usually sufficient for thicker walls to resist temperature stresses, etc. Therefore, the following minimum reinforcing shall be used:

Walls 1'-0" thick or less, use #4 @ 18" in both faces in both directions;
Walls over 1'-0" up to 3'-0", use #4 @ 12" in both faces in both directions;
Walls 3'-0" thick and over, use #5 @ 12" in both faces in both directions; and
All abutment faces, use #5 @ 12" in both faces in both directions.

Doweling into Existing Concrete

The designer may wish to use dowel bars to tie new concrete into an existing structure. If dowels are shown on the Plans, then they shall be at least 6" from the face of any concrete surface. The minimum size of dowel bars shall be #6 and the diameter of the dowel holes shall be at least the dowel bar diameter plus 1/2". When dowel bars are called for the following note shall appear on the appropriate Plan sheet:

> "Grout for dowels shall be a non-shrink epoxy grout consisting of sand and epoxy mixed by volume according to manufacturer's recommendations and capable of developing a minimum compressive strength of 6500 psi in 72 hours when tested in accordance with M.S.M.T. 501. Sand for epoxy grout shall conform to Section 901.01 of the Specifications."

If more than one substructure unit on the same bridge is affected, these notes shall appear on only one sheet and referenced on all others.

Spiral Reinforcing for Circular Bridge Pier Columns

All circular pier columns whose diameter is 7'-0" or less shall be designed using spiral reinforcing. When spirals are used, include the General Notes for column spirals on the Contract plans. Circular columns greater than 7'-0" in diameter shall not use spirals, but shall utilize another form of tie detailing.

This requirement is based on shipping limitations. The Concrete Reinforcing Steel Institute recommends a maximum width of 7'-4" for shipping in an effort to limit the bar bundle size to the 8'-0" maximum load width. Generally, shipping widths greater than 8'-0" require the permission of authorities or must be shipped under special freight rates.

Hammerhead Type Piers – Cap Reinforcing Steel

All main reinforcing steel in the top of caps required for the "cantilever/corbel" portion of cap shall be properly anchored at ends of caps and extend continuously across the entire length of the cap. These bars shall not be spliced, unless the lengths of the bars are such that splicing cannot be avoided. If splicing is required, it shall be accomplished by alternating the location of the splices of adjacent bars near the center of the cap.

MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION	Office of Structures ***Guidelines and Procedures Memorandum***	DESIGN Number: D-18-52(4) Date: 03-16-2018
	Structural Steel	Approval:

The following guidelines and procedures relate to the design of bridges containing structural steel and shall be used in conjunction with the AASHTO LRFD Bridge Design Specifications.

Steel Selection

Grade 50 Steel shall be used for all new structural steel members.

Grade 70 Steel may be used upon approval by the Director.

Grade 50W (Weathering Steel) may be used when the conditions warrant. Bridges over water or those in wet environments shall not use weathering steel. All weathering steel shall be painted.

Minimum Sizes of Steel Members and Welds in Bridges

All primary fabricated structural steel members, such as stringer flanges and webs, crossframes for curved stringers, floor beams, truss members, cover plates, splice plates, stiffeners, connection plates, etc., in the bridge superstructure shall have a minimum thickness of 1/2". All secondary fabricated structural steel members, such as wind bracing and diaphragms, in the bridge superstructure shall have a minimum thickness of 3/8". The minimum thickness criteria applies to rolled sections as well as built-up members. Particular attention must be given to selecting small rolled sections so as to avoid sections having webs, flanges or legs of less than the minimum thickness. The only exception to the minimum thickness requirement will be for filler plates at splices. The minimum sizes of steel members are set to allow for potential section loss over the life of a structure.

Other minimum size criteria are as follows:

Girder Flange Width:	12"	All flange plates shall have a width to thickness ratio of 12 or less.
Girder Flange Thickness:	1"	
Weld Size:	5/16" (except for seal welds)	
Stiffener Width:	To nearest 1/2" and about 1/2" $\pm$ less than distance from face of webs to edge of flange, but not over 10 times the stiffener thickness for Grade 50 steel.	

Haunched Girder Bridges

In an attempt to improve the appearance of our bridges, haunched girders should be considered wherever possible. This could require adjusting the grades to accommodate the deeper girder depth. If a structure appears to be a good candidate for haunched girders, such as a two span bridge overpass or the long span main channels of a bridge over navigable waters, allowance should be made early on in the project before grades are set.

At the preliminary stage, estimate the depth of the haunch to be twice the depth of the girder at mid span and the length to be approximately one third the span length. The haunches shall come to a point (width of the bearing) at the pier(s) and the angle at the point of the haunch shall be between 135 and 160 degrees. The dimensions can be adjusted in the final design. Provide the required clearance over the proposed roadway, including shoulders, as well as over any future widening if the roadway underneath allows for widening under the haunched section.

Splices in haunched girders shall be placed outside of the haunched section which may move the splice away from the dead load inflection point (DIP). The design of the splice shall account for additional loading introduced at the splice location.

Cover Plates on Steel Stringers

All MDOT SHA bridges utilizing steel stringers shall be designed without cover plates.

Intermediate Stiffeners for Plate Girders

The webs shall be designed without intermediate stiffeners.

Shear Connectors in Negative Moment Regions

Continuous composite stringers are to be designed as non-composite in the negative moment regions. Beyond the point in negative moment regions where shear connectors cease to be required by AASHTO, shear connectors shall be called for at 24-inch maximum spacing using the same number per row and size of studs as used throughout the bridge.

On rare occasions, because of span configuration, an entire span may develop negative moment. The same criteria indicated above shall prevail through these areas.

Shear connectors on existing steel stringers for bridges being analyzed for a deck replacement shall be evaluated to determine if they need to be modified for use in the new bridge deck.

Camber of Steel Beans and Plate Girders

All steel stringers of less than 50 feet span, which support concrete deck slabs, shall not be cambered to compensate for dead load deflection or to correct for vertical curve ordinates. For these stringers, the following note shall be placed on the contract drawings:

> "No dead load and vertical curve camber is required for Beams (Girder) No. XX of Spans No. XX. If these beams are not rolled exactly true they shall be fabricated and erected with their concave sides down with a camber tolerance of three quarters (3/4) inch over."

All steel stringers of 50 feet span or more, which support deck slabs, shall be cambered to compensate for dead load deflection, and vertical curve ordinates (additional camber for hump vertical curves less for sag vertical curves). For these stringers the following note shall be placed on the contract drawings:

> "Beam (Girders) No. XX of Spans No. XX shall be cambered for dead load deflection (and vertical curve ordinates, if applicable) to the dimensions shown on these plans. The camber tolerance is nothing under to three quarters (3/4) inch over."

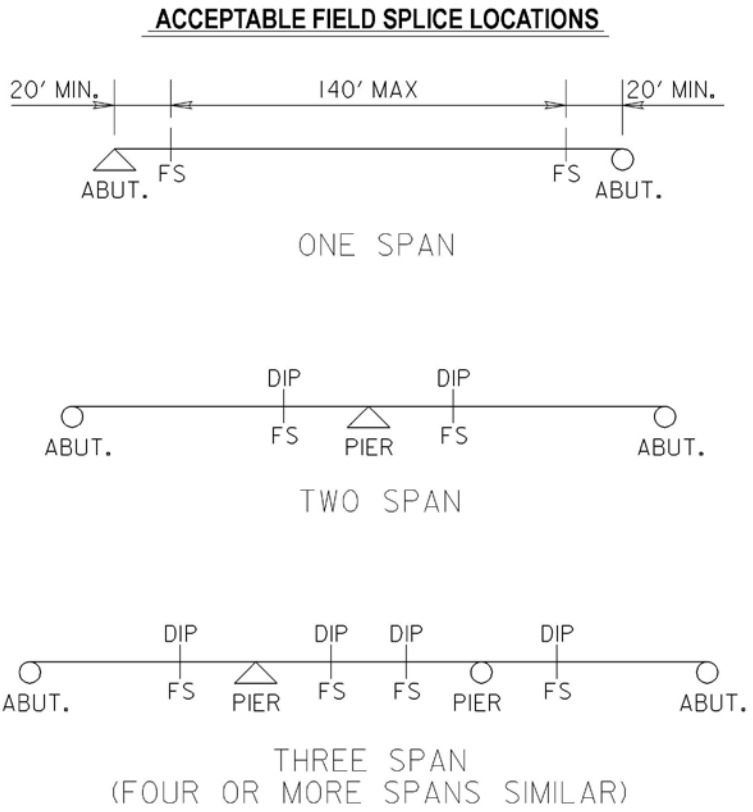
Dead load deflections shall be computed and shown at the points corresponding to the elevations shown on the finished roadway elevation sheets. These deflections shall be shown in a schedule, as separate entries for weight of stringers, concrete slab, and superimposed dead loads. These schedules shall also show the camber required for vertical curve ordinate at the same points. A separate entry showing the total deflection for all dead loads and the correction for vertical curve ordinate shall also be shown.

Field Splices for Steel Beams and Steel Stringers

All field splices shall be bolted.

The minimum number of field splices shall be the number of piers over which the stringer is continuous. Designers may consider a lesser number of field splices on rolled beam bridges with spans less than 60 feet long.

The diagrams below show the acceptable field splice locations (marked FS) for a stringer. Additional splices may be required due to span lengths, fabrication difficulties, etc. and each project shall be evaluated by the designer to ensure adequate splices are supplied. (Designers must verify with a steel fabricator the feasibility of shipping a stringer segment, with a length greater than 140 feet, to the project site prior to detailing it on the Plans.) DIP means dead load inflection point.



The contract plans shall indicate the acceptable field splice locations as well as the minimum number of field splices to be used for each stringer. If the design required more than one type of field splice (4 columns versus 6 columns of bolts in a web splice, and/or different size splice and/or fill plates, and/or different bolt spacing, etc.) then a separate detail will be drawn for each type of splice. The use of tables listing different plate sizes for various types of bolted field splices is unacceptable. Designers should make an effort to limit the number of types of bolted field splices in a design. If the largest field splice will work geometrically at the other field splice locations, then the designer should consider the difference in cost between the types of splices. If the difference in cost is less than 25% of the largest field splice's cost, then the largest field splice should be used at both locations.

Specifying Fit Up Condition

For straight bridges where one or more support lines are skewed more than 20 degrees from normal and horizontally curved girders meeting the requirements of AASHTO Article 6.7.2, the following fit up conditions for the cross-frames or diaphragms shall be specified on the contract plans.

- Steel Dead Load Fit (SDLF) for straight steel girder bridges.
- Steel Dead Load Fit (SDLF) for curved steel girder bridges.

For unusual situations where SDLF may introduce significant forces in the girders due to the application of the bridge deck and parapets and railings, a request may be submitted to the Director of the Office of Structures to use an alternative fit up condition such as Total Dead Load Fit (TDLF). Any submitted request must clearly document the advantages / disadvantages of one method over another from a stress and cost perspective.

MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION	Office of Structures ***Guidelines and Procedures Memorandum***	DESIGN Number: D-18-53(4) Date: 03-16-2018
	Prestressed Concrete	Approval:

The following guidelines and procedures relate to the design of bridges containing prestressed concrete and shall be used in conjunction with the AASHTO LRFD Bridge Design Specifications.

Concrete for Prestressed Girders and Slabs

The minimum 28-day compressive concrete strength specified for all prestressed concrete girders and slabs shall be 8000 psi. The designers shall use 7000 psi for all design calculations. The minimum compressive strength at the transfer of prestress shall be 5800 psi.

The use of lightweight concrete in prestressed concrete elements is prohibited.

Use Self Consolidating Concrete (SCC) for all prestressed concrete girders and slabs.

Prestressing Strands

Use bright ½" diameter 7-wire low relaxation strands for all prestressed concrete girders and slabs. The minimum center-to-center spacing of all strands shall be 2".

Strands shall be placed either straight or harped. Based on the recommendations of the PCI manual (PCI 3.3.2.2.2), the slope of harped strands shall not exceed 9 degrees. Hold down forces at any single harping point shall not exceed 48 kips. In most cases, approximately 12 strands or less can be harped at one point to meet this provision. If more than 48 kips of hold down force is needed for all of the harped strands, the strands that are to be harped shall grouped into multiple harping points that are separated by a minimum of 5 feet.

Debonding any strands in prestressed concrete girders and slabs is prohibited.

For the final design of all prestressed concrete girders and slabs, the refined time-dependent losses in AASHTO-LRFD 5.9.5.4 shall be calculated in lieu of the approximate time-dependent losses in AASHTO-LRFD 5.9.5.3. The following assumptions shall be made:

1. Relative humidity (H) = 75% for Districts 1 and 2, 70% for Baltimore City and Districts 3, 4, 5, 6, and 7
2. Age at Transfer (t_i) = 1 day
3. Age at deck placement (t_d) = 28 days
4. Final Age (t_f) = 36,525 days (100 years)

Mild Reinforcement

For prestressed concrete slabs, only #5 or #6 sized bars can be utilized for the design. For prestressed concrete girders with span lengths less than 150 feet, only #4 or #5 sized bars can be utilized for the design. A note shall be added to the plans to allow a contractor to substitute #3 or #4 bars for the required bars as long as the spacing of the bars is adjusted to match the area of steel per foot of girder.

The minimum center to center spacing of any mild reinforcement bars within prestressed concrete girders and slabs shall be 3".

Minimum clear cover for all mild reinforcing steel shall meet the following:

TYPE OF ELEMENT	LOCATION	CLEAR COVER
Prestressed concrete slabs	Entire perimeter	2"
Prestressed concrete girders	At the bottom of bottom flange	2 ½"
	Around the web and top flange	1 ¼", if #4 bars are used 1 1/8", if #5 bars are used
	Everywhere else	2"

When determining the final shear resistance for all prestressed concrete girders and slabs, the general procedure in AASHTO-LRFD 5.8.3.4.2 shall be calculated in lieu of the simplified procedure in AASHTO-LRFD 5.8.3.4.3.

If the maximum bar size (#5) at the minimum spacing (3") is utilized in the design of some prestressed girders, it may be impossible to conform to the provision in AASHTO-LRFD 5.10.10 for the pretensioned end anchorage zones. If this is the case, the area of reinforcement for end anchorage shall be calculated using all stirrups within a distance of "h" (in lieu of h/4 from AASHTO-LRFD) from the end of the girder, where "h" is the depth of the girder. In all cases, the stirrup reinforcement for prestressed girders shall be spaced at 3" for a distance of "h" from the end of the beam.

Diaphragms

For prestressed concrete girders with a span length between 50 and 100 feet, a single diaphragm shall be place at the midspan of the girders. For prestressed concrete girders with a span length greater than 100 feet, three diaphragms shall be placed at the quarter points of the girders. All diaphragms shall be oriented to be parallel with the centerline of bearing.

The plans shall show cast-in-place concrete details for these elements. At the request of the contractor or if accelerated bridge construction methods are required, the use of precast concrete diaphragms can be utilized. The use of steel diaphragms on prestressed girders is prohibited.

Making spans continuous for live loads

In new multiple span prestressed girders and slabs, the superstructure elements may be connected together to make them continuous for superimposed dead loads and live loads. The girders or slabs and the non-composite dead loads shall be designed and constructed as simply supported beams.

To make the connection between simply supported beams the provision of AASHTO-LRFD 5.14.1.4 will be used. Reinforcement bars (in lieu of the strands or any other system) shall be used to make the connection at the bottom of the girders over the pier as specified in AASHTO-LRFD 5.14.1.4.9b. The age of the girder or slab when continuity is established shall be assumed to be 28 days. Thus, the assumptions in AASHTO-LRFD 5.14.1.4.4 cannot be applied and a positive restraint moment must be calculated using the following assumptions:

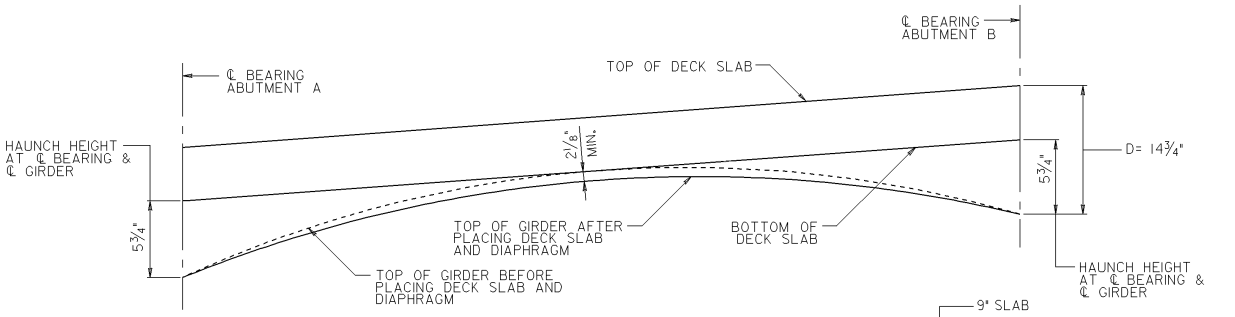
1. Girder concrete ultimate creep coefficient = 2.4
2. Girder concrete ultimate shrinkage = 750 microstrands
3. Deck concrete ultimate shrinkage = 550 microstrands
4. Time between tensioning of strand and prestress transfer = 1 day
5. Time between prestress transfer and establishment of continuity = 28 days
6. Time between prestress transfer and placement of deck = 31 days
7. The restraining effect of the slab reinforcement on shrinkage will not be considered.

For in-house designs, there is a post processor portion of Merlin-Dash that designs this connection using these assumptions as default settings.

Camber and Haunch Depth

Camber calculations for prestressed girders and slabs shall not include the effects of future wearing surfaces.

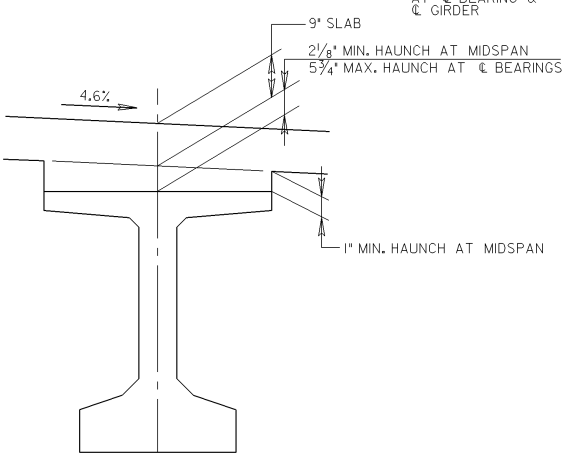
Since the camber calculations for concrete girders assume a minimum concrete strength, the camber values may be different from actual girder. If the concrete strength of the girder is higher than the minimum strength, the girder will achieve less camber. To account for differences in the camber, the haunch depth of the girder (the distance between the top of girder and bottom of deck) will vary along the length of the girder. Using the theoretical camber values, the vertical profile of the bridge, and the cross slope of the roadway, designers should determine the haunch depth at the centerline of the support bearings to achieve a 1" minimum haunch at mid-span of the girder on the outside edge of the flange. This 1" minimum haunch should be calculated assuming that the deck and diaphragms have already been poured and the girders have deflected from their full weight. See sketch below.



CAMBER DIAGRAM
SCALE: NONE

NOTES FOR CAMBER:

1. "D" IS MEASURED FROM THE TOP OF DECK SLAB TO TOP OF GIRDER AT ℄ BEARINGS.
2. SUPERIMPOSED DEAD LOAD (S.D.L.) INCLUDES THE EFFECTS OF THE CONCRETE PARAPET. IT DOES NOT INCLUDE THE EFFECT OF THE FUTURE WEARING SURFACE.
3. CAMBER DUE TO PRESTRESS FORCE PLUS DECK SLAB DEAD LOAD TO BE CHECKED IN THE FIELD PRIOR TO PLACEMENT OF DECK SLAB FORMS. FINISHED GRADE ELEVATIONS SHALL BE OBTAINED BY ADJUSTING THE HAUNCH DEPTH OF THE DECK SLAB TO ACCOMMODATE ANY DIFFERENCE BETWEEN THE PROPOSED AND ACTUAL CAMBER AND DEFLECTIONS.
4. PRESTRESS CAMBER AND DEAD LOAD DEFLECTION DATA SHOWN ARE THEORETICAL AND WILL VARY DEPENDING ON CONCRETE STRENGTH, STORAGE TIME, VARIBLE PRESTRESSING CONDITIONS, ETC.
5. THE CAMBER AND DEAD LOAD DEFLECTION DATA SHOWN ARE THE THEORETICAL VALUES FOR THE ENTIRE BRIDGE DECK SLAB AFTER ALL STAGES OF CONSTRUCTION.
6. GIRDER DEFLECTIONS SHALL BE CHECKED AFTER DECK SLAB POURS AND THE SCREED SETTINGS FOR SUBSEQUENT POURS SHALL BE MODIFIED AS REQUIRED SUBJECT TO THE APPROVAL OF THE ENGINEER.
7. VERTICAL CURVE CAMBER WILL BE HANDLED BY VARYING THE HAUNCH DEPTH.
8. THE HAUNCH DEPTH WILL VARY OVER THE TOP FLANGE DUE TO THE CROSS SLOPE IN THE DECK. THE HAUNCH DEPTH SHALL BE NO LESS THAN 1" AT THE EDGE OF THE TOP FLANGE.



GIRDER SECTION
SCALE: NONE

When designing the girder, a 1" haunch depth shall be used to determine the section properties of the composite girder. The maximum haunch depth shall be used when determining its uniform weight over the length of the beam.

MARYLAND DEPARTMENT OF TRANSPORTATION STATE HIGHWAY ADMINISTRATION	Office of Structures ***Guidelines and Procedures Memorandum***	DESIGN Number: D-18-54(4) Date: 07-27-2018
	Retaining Walls/ Wing Walls	Approval:

The following guidelines and procedures relate to the design of retaining/wing walls and shall be used in conjunction with the AASHTO LRFD Bridge Design Specifications.

Geometric Design Criteria

Retaining/Wing Wall geometry shall be established in accordance with the following:

A. The length of proposed retaining/wing walls shall be set so that the wall extends a minimum of 1'-6" beyond the location where the contours intersect.

B. Retaining/wing walls on curved horizontal alignments may be constructed on chords, unless otherwise stated, provided the angle of deflection between segments does not exceed 5 degrees.

C. The horizontal offset of the wall from the baseline shall not change abruptly. All changes in offset shall be accomplished using curves or chorded construction as described above.

D. The top of retaining/wing walls shall not be stepped or contain sharp breaks in slope to accomplish a change in elevation. The top shall be level or shall vary using a smooth linear or curved transition.

E. The completed retaining/wing wall, and all associated structural elements, shall be located entirely within the Administration's Right-of-Way. Construction easements shall only be used to facilitate construction efforts.

F. The ground line behind the retaining/wing wall shall be placed a minimum of 9" below the top of the wall, unless a barrier is required on top of the wall.

G. The retaining/wing wall footing shall be extended to the end of the wall (we are no longer providing a 5' overhang).

Structural Details for Retaining Walls/Wing Walls

MDOT SHA Structural Details shall be utilized whenever possible. If the Structural Details are modified in any way; the details shall be removed from the Detail section of the plans and included with the wall drawings as a non-standard element.

The following structural details shall be used where appropriate:

A. On all projects proposing the use of cantilever CIP retaining/wing walls with either a two-foot surcharge or a maximum 2:1 sloping backfill, the appropriate Retaining Wall Structural Detail (RW-101 through RW-109) shall be evaluated for the design of these retaining walls and wing walls. It is the responsibility of the designer to evaluate the project parameters to determine if the Structural Details are applicable. Parameters that may inhibit the use of the Structural Details include, but are not limited to, geometric restrictions, wall height, soil conditions, right-of-way requirements, traffic impact, and special aesthetics. If the Structural Details are not utilized, documentation as to why they are not being incorporated into the plans must be submitted to the Director of the Office of Structures for concurrence. If no constraints exist, the retaining wall and/or wing wall shall be selected using the appropriate Structural Details.

B. If the retaining/wing wall is on piles, a pile layout, add all normal pile notes including size, estimated tip, design load, etc., must be included in the Contract Plans for each wall, using Detail No. RW-108 or RW-109 as guidance for the pile spacing. The pile layout must include the layout of the 3 - #6's each way over the piles.

C. For retaining walls supporting roadways and adjacent to the shoulder, an F-Shape Barrier shall be placed on top of the proposed retaining wall. The height of the proposed barrier shall be 42" in accordance with the roadway design requirements.

D. For retaining walls adjacent to and supporting sidewalks, a 2'-8" vertical face barrier with a one strand rail resulting in a combined barrier height of 3'-6" shall be utilized. Where fencing is required, the one strand railing shall be eliminated, and a Type II or Ornamental Fence shall be placed on top of the barrier in accordance with the Structural Details.

E. For barriers placed on top of MSE walls, a moment slab shall be utilized to resist the horizontal loads applied to the barrier. The moment slab and barrier shall be cast-in-place. The moment slab may not be part of the roadway surface.

F. For retaining walls (excluding wing walls) supporting private property or other facilities that are accessible to pedestrians, fencing shall be provided on top of the wall. The minimum height of the fence shall be 3'-0" and detailed in accordance with the Structural Details. If an ornamental fence is required per the structures aesthetic specifications, the fencing details shall be developed in accordance with those requirements.

G. All retaining/wing walls shall contain the appropriate details for drainage. The drainage system for cast-in-place cantilever walls shall be in accordance with Detail No. RW(0.01)-80-100.

Design Alternates for Retaining Walls

The design for permanent retaining walls shall follow one of the following alternates. Only one alternate shall be used per wall location.

Cast-in-Place (CIP) Cantilever Retaining Walls

CIP Walls shall designed and detailed in accordance with Structural Detail Nos. RW(6.02)-83-133 through RW(6.14)-89-201, when possible. It shall be noted that the Structural Details have been developed without a traffic impact load (or barrier). The Designer must modify the wall design to meet current code for traffic impact when supporting a roadway.

Proprietary Retaining Walls

Proprietary retaining walls shall be designed and detailed in accordance with the manufacturer's approved details. The list of proprietary retaining wall systems that have been approved by the Administration are located on the Administration's website www.marylandroads.com under the section Business with SHA.

A. Mechanically Stabilized Earth (MSE) retaining walls that are to be placed adjacent to streams, floodplains, SWM ponds, or other water features shall be placed so that no stream flows up to the 100 yr flood elevation or standing water comes in contact with the face of the wall. A solid concrete barrier may be designed to protect the base of the wall and shall contain the appropriate scour countermeasures.

B. The leveling pads for proprietary retaining walls shall be cast-in-place concrete. They are considered spread footings and shall follow the design requirements for spread footings.

C. The reinforced zone backfill for Mechanically Stabilized Earth (MSE) walls shall be comprised of No. 57 stone. A phi angle of 34 degrees shall be used for No. 57 stone in the design calculations.

Top-Down Retaining Walls.

Top-down retaining walls shall be designed and detailed in accordance with AASHTO and the following:

A. All loads shall be resisted by the soldier piles, lagging, or other elements in direct contact with the retained soil.

B. Only concrete lagging shall be used for permanent retaining walls. The use of type of timber lagging will not be permitted.

C. A concrete facing shall be provided that will not be considered structural in nature. The aesthetic finish for the concrete facing shall be as outlined in the contract documents.

D. Portions of permanent steel elements, which are exposed after excavation, shall be coated in accordance with Section 465.